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ABSTRACT

This guide is intended to assist vocational educators in teaching a six-unit module in basic welding skills. The module is part of a welding curriculum that has been designed to be totally integrated with Missouri's Vocational Instruction Management System. The following topics are covered in the module: the welding profession, personal safety, first aid, shop safety, welding tools and equipment, and math and measurement. The materials included in the module have been formatted for competency-based teaching and testing. All information sheets, transparency masters, job sheets, assignment sheets, and test items are keyed to specific competencies, and a cross-reference table has been included to aid in identifying the parts of the curriculum that relate to specific competencies. Unit tests to evaluate specific competencies have also been provided. (MN)

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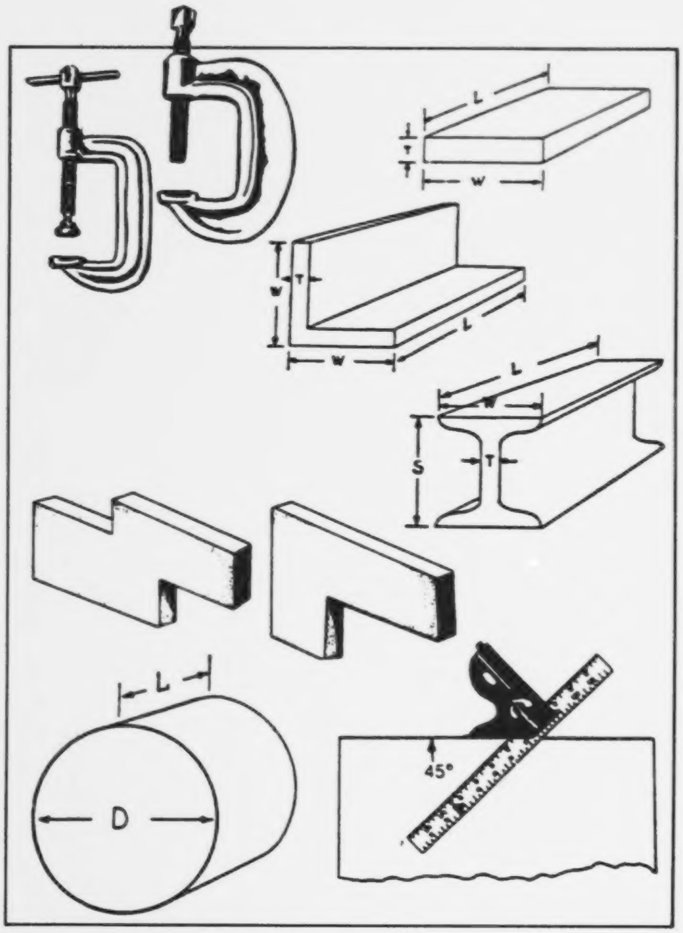
Instructor's Guide

WELDING • Module 1

Basic Welding Skills



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IMI

WELDING

Instructor's Guide

Modules:

Basic Welding Skills
Print Reading, Layout and Fit-up
Oxy-fuel Cutting/Welding
Shielded Metal Arc Welding (SMAW)
Gas Metal Arc Welding (GMAW)
Gas Tungsten Arc Welding (GTAW)
Metallurgy and Heat Treating
Plasma Cutting and Carbon-arc Cutting

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BEST COPY AVAILABLE

FOREWORD

Once again, we are indebted to the teachers and administrators who provide their time, efforts and professionalism to develop curriculum for trade, technical and industrial education programs. This welding guide is an outstanding example of what can be accomplished when the right people with the right attitude get together. The curriculum writers and subject matter experts who worked on this guide are to be commended for a job well done.

The welding curriculum guide is one of the first guides designed to be totally integrated with the Vocational Instructional Management System. It is hoped that all guides produced under our supervision will help classroom teachers manage instruction. A curriculum guide is more than a resource--it is an integral part of the management system. Rather than impeding instruction, it should guide and facilitate instruction.

This guide's format has been set up for competency-based teaching and testing. Unit tests evaluate specific competencies and can be used with the Vocational Administrative Management System (VAMS). All information sheets, transparency masters, job sheets, assignment sheets and test items are keyed to specific competencies. A cross-reference table has been included to quickly identify parts of the curriculum that relate to specific competencies. The material has also been packaged for students.

Although this guide may be a new format and new system for many teachers, we are confident that, when used as designed, time spent by teachers and students will become more productive. Any future welding curriculum modifications will begin with this guide. Welding, like many technical fields, is undergoing constant and considerable change. We will annually evaluate the need to update this guide on a module-by-module basis. Your suggestions regarding areas for improvement are both encouraged and appreciated.

Judith Perryman, supervisor
Industrial Education
Department of Elementary and Secondary Education

Steve Long, director
Industrial Education
Department of Elementary and Secondary Education

ACKNOWLEDGMENTS

This welding guide represents a continuing commitment to Missouri's Vocational Instructional Management System (VIMS). The guide has been keyed to the welding competency profile developed by industry and education professionals in the state.

When searching for current welding materials to adopt or utilize in the guide's development, comparable materials were found from the Mid-America Vocational Curriculum Consortium (MAVCC), of which Missouri is a member. MAVCC materials, therefore, have been relied heavily upon as a resource for this guide. A debt of thanks is owed to the entire MAVCC organization for the research and development of these welding materials.

Special appreciation is given to Roger Day and Eric Rygaard, who were the curriculum writers for the project. Thanks is also given to staff and members of the American Welding Society for their input and expertise.

These industry representatives and educators contributed to the guide as members of the advisory committee.

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Jerry Swaim; South County Technical School; St. Louis, Mo.

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Steve Cochran; Mexico Area Vo-Tech; Mexico, Mo.
Otis "Pete" Letterman; Graff Area Vo-Tech School; Springfield, Mo.
Duane Lighthill; North Central Area Vo-Tech; Bethany, Mo.
Ken Lutz; North Co. Technical School; Florissant, Mo.
Tom McLaughlin; Chillicothe Area Vo-Tech; Chillicothe, Mo.
J. C. Niday; Kansas City Technical Education Center; Kansas City, Mo.
Robert Williams; St. Fair Community College; Sedalia, Mo.

Technical reviewers who contributed to the guide's development include Don Johnson and David Baird of the University of Missouri-Columbia.

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Instructional Materials Laboratory
University of Missouri-Columbia

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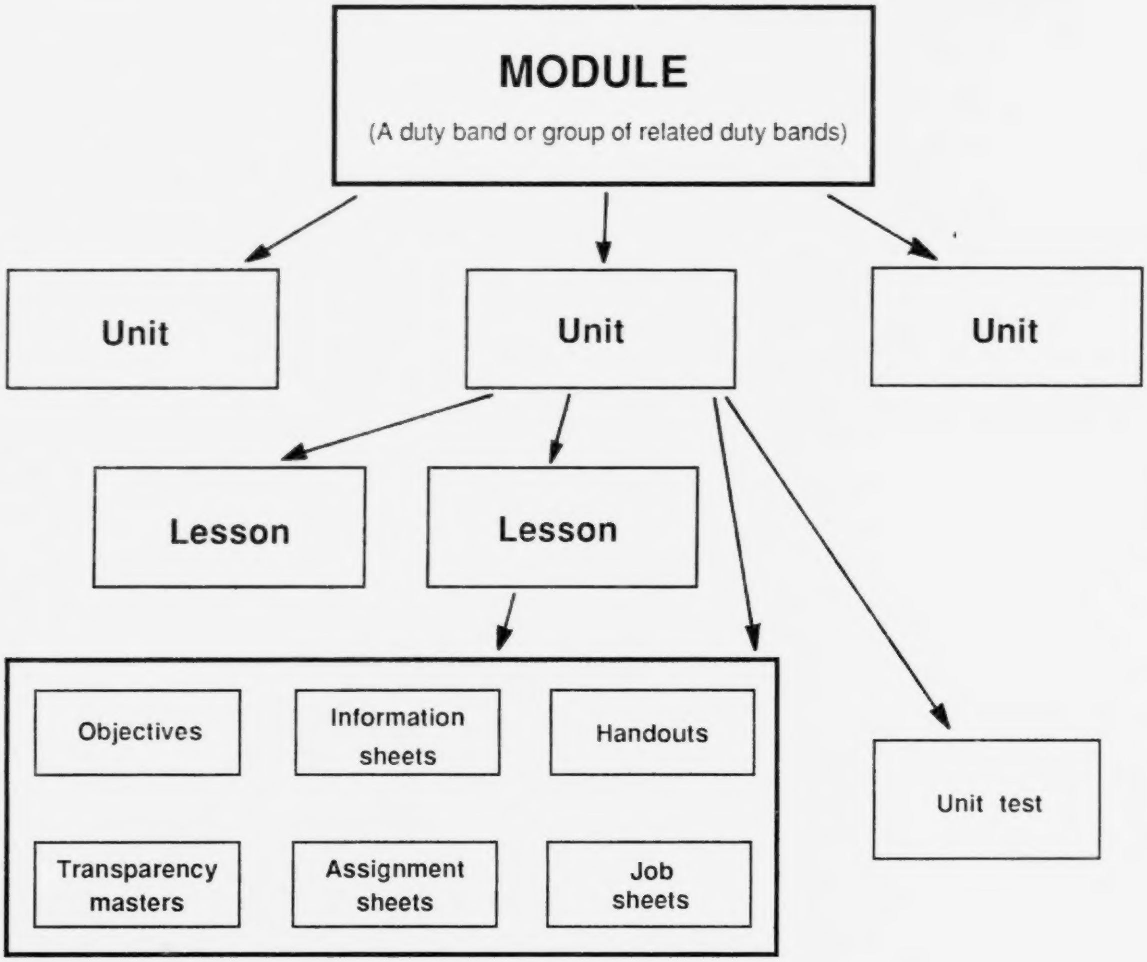
HOW TO USE THIS PUBLICATION

GUIDE COMPONENTS

Units of instruction

This Welding guide contains eight modules of instruction. Within each module are instructional units including some or all of the following components: performance objectives, information sheets, handouts, transparency masters, assignment sheets, job sheets and a unit test. Special instructions on audiovisuals, supplies, etc. are included in the Notes to the Instructor section near the beginning of each unit.


MODULE
(A duty band or group of related duty bands)
Unit
Unit
Unit
Lesson
Lesson
Objectives
Information sheets
Handouts
Transparency masters
Assignment sheets
Job sheets
Unit test

Objectives (color-coded white)

Each unit is based on performance objectives which state the measurable unit and specific behavioral or performance objectives that students are expected to achieve. Since the objectives of the unit provide direction for the teaching-learning process, it is important for the teacher and students to have a common understanding of the objectives' intent. Teachers should feel free to add/adapt objectives which will fit the material to student and community needs. Supporting material will, of course, need to be added for any new objectives.

Table of contents, references, notes to the instructor (color-coded pink)

These pages have been coded pink for instructor use only. The reference section lists materials used as sources in developing the material. Special instructions on audiovisuals, supplies, etc. are included in the Notes to the Instructor section.

Information sheets (green)

Presented in outline form for clarity, these pages provide content essential for meeting the cognitive (knowledge) objectives in the unit. Students should study the information sheets before class discussion or completion of assignment sheets. Handouts and transparency masters have been keyed in the information sheets for instructional use.

Transparency masters (white)

Transparencies provide information by visually reinforcing or clarifying ideas presented in the information sheets. They are effective when identification is necessary and direct the class's attention to the topic of discussion. Transparencies should be left on the screen only when topics shown are under discussion, however.

Handouts (white)

Whenever more detailed information than can be presented in a transparency is needed, a handout is used. Handouts give the students additional information that can be kept with their class notes or student references.

Assignment sheets (tan)

Assignment sheets furnish paper-and-pencil practice to develop the knowledge necessary as a prerequisite to skill development. They can be given to students for class completion or used as homework assignments. Answer sheets (color-coded pink) can be used by the student or instructor to check progress.

Job sheets (blue)

These evaluation instruments are provided for two purposes: to outline steps of procedure and to check student performance mastery. Job sheets begin with a list of tools and materials needed for the activity. Job sheets furnish potential employers with a picture of skills being taught and performance which might be reasonably expected from a vocational student.

Unit test (yellow)

Competency-based tests are designed to help eliminate subjective testing and to improve student evaluation and accountability. Specific competencies and test questions are linked on the answer key. These welding unit tests have been written to be used with computerized VAMS (Vocational Administrative Management System), utilizing Scantron sheets for computer-recording of test answers.

The unit test may be eliminated if the competency was thoroughly evaluated by job sheets. However, an emphasis should be placed on cognitive as well as performance skills. If the objective or competency will be evaluated by a job sheet, it is often necessary to determine by a written test whether the student understands enough of the material to perform the job sheet.

SUGGESTED ACTIVITIES

The following list of suggested activities may be helpful, especially to the beginning instructor.

1. Provide students with objective sheet and information sheets.
2. Discuss unit and specific objectives.
3. Discuss information sheets, assignment sheets and/or job sheets, lesson-by-lesson.
4. Have students do assignment sheet(s) to satisfactory levels.
5. Give students unit test.
6. After successful completion of the test, have students do job sheet(s).

Students should perform the following activities.

1. Read objective sheet.
2. Study information sheets.
3. Do assignment sheet(s).
4. Take unit test.
5. Do job sheets.

PACKAGING

This Welding guide has been packaged with the entire class in mind. For the teacher, a complete instructor's guide contains all eight modules. In the student reference, selected portions have been reproduced for student use (objectives page, information sheets, handouts). Student work sheets (assignment sheets, job sheets, unit tests) have been packaged together for student distribution as the instructor deems necessary.

In the student reference, page numbers do not run consecutively because some pages have been removed that appear only in the instructor's guide.

Module: Basic Welding Skills

Cross-Reference Table of Instructional Materials

Competency	Instructional Objective	Transparency Master	Handout	Assignment Sheet	Job Sheet	Test Item	Notes
A1	II 1.1-3.2	II 2.1, 3.1, 3.2	IV 1.1	II 1.1, 2.1		II 1-20	
A2	IV 4.1, 4.2			IV 1.1, 4.1		IV 1, 2, 12-14, 16, 18-21	
A3	IV 3.1-3.4		IV 3.1			IV 6-11	
A4				IV 1.1, 4.1		IV 17	
A5	IV 2.1-2.3			IV 2.1			
A6	IV 1.3, 4.4	V 1.1, 1.2		V 1.1, 2.1	VI 1.1, 1.2	IV 3-5, 15, V 32, 33, 36, 37	
A7	VI 1.1, 1.2		VI 1.1-1.3	VI 1.1			
A8	VI 2.1-4.1			VI 2.1-2.3, 3.1-3.3		VI 1-29	VI pretest
A9	V 1.1, 2.2	V 2.1-2.4		V 1.1, 2.1			
A10	V 1.2-1.5, 2.1, 2.3-3.3 VI 1.3	V 1.1, 1.2, 3.1		V 1.1, 3.1	VI 1.1, 1.2	V 1-15	
A11	V 4.1-4.3			V 4.1		V 16-31, 34, 35	
A12	V 1.6					V 38, 39	
A13					III 2.4		in Oxy-fuel module
A14						II 12-15	in SMAW module
A15	I 2.2, 2.3	I 2.1			I 2.1, 2.2		in GMAW module

MODULE: BASIC WELDING SKILLS

UNIT I: ORIENTATION

UNIT OBJECTIVE

Upon completion of this unit, the student should be able to discuss job opportunities and personal requirements for welders. This knowledge will be evidenced by achieving a specified score on the unit test.

SPECIFIC OBJECTIVES

After completion of the lessons this unit, the student should be able to:

1.1 Identify groups which have helped standardize the welding industry.

1.2 Describe welding products and manufacturing centers.

1.3 Identify welding employment opportunities.

1.4 Identify personal requirements for a successful welder.

2.1 Match welding terms with definitions.

MODULE: BASIC WELDING SKILLS

UNIT I: ORIENTATION

CONTENTS OF THIS UNIT

A. Objective sheet

B. References

C. Notes to the instructor

D. Lesson plans

  1. Lesson 1: INTRODUCTION TO THE WELDING PROFESSION

    a. Information outline

    b. Transparency master

      TM 1.1: Attitudes that promote job advancement

    c. Handout

      HO 1.1: Professional organizations

  2. Lesson 2: WELDING AND CUTTING PROCESSES

    a. Information outline

    b. Handouts

      HO 2.1: Welding processes
      HO 2.2: Allied processes

E. Unit test

F. Answers to unit test

REFERENCES

A. Books

1. Guza, Michael, et al. Welding Glossary of Key Words. White Bear Lake, Minn.: Minnesota Instructional Materials Center, 1973.

2. Sacks, J. Raymond. Welding Principles and Practices. Peoria, Ill.: Charles A. Bennett Co., Inc., 1976.

3. Occupational Outlook Handbook, 1984-85 ed. Washington, D.C.: U.S. Department of Labor, Bureau of Labor Statistics, 1984.

4. Pocket Welding Guide. Troy, Ohio: Hobart Brothers Company, 1980.

5. The Metal Craftsman's Handbook. Athens, Geo.: American Association for Vocational Instructional Materials, 1980.

6. The Procedure Handbook of Arc Welding. Cleveland: The Lincoln Electric Company, 1973.

7. Welding Procedure and Performance Qualification. Miami: American Welding Society, 1977.

B. Curriculum guide

1. Fortney, Clarence, and Mike Gregory. Introduction to Welding. Stillwater, Okla.: Mid-America Vocational Curriculum Consortium, Inc., 1984.

NOTES TO THE INSTRUCTOR

A. Suggested approaches to teaching this unit

1. Invite a local or area officer of the American Welding Society to talk to the class about AWS activities and the concept of welding industry standards.

2. Start an AWS student chapter at your school; discuss how this can be accomplished with a local AWS official. Membership benefits include journals on up-to-date technology and industrial changes.

3. Ask the VICA coordinator to talk to students about VICA objectives, benefits of being a VICA member and procedure for VICA membership.

4. Bring in an outside industry speaker (usually from personnel department) or a former student to let students know what employers are looking for. Take students on industry field trips.

B. Suggested student activities

1. Have students select an organization from HO 1.1 to write for membership information and the organization's objectives.

C. Suggested supplemental material (videotapes) from the Media Center, State Fair Community College, Sedalia, Mo.

1. Competency-Based Education--What Is It? (W-80-500). 1980.

2. Procedures for Implementing Competency-Based Education (W-80-501). 1980.

3. Opportunities in Welding (W-88-1000). 1988.

4. Welding: A Program Overview (W-88-1100). 1988.

MODULE: BASIC WELDING SKILLS

UNIT I: ORIENTATION

LESSON 1: INTRODUCTION TO THE WELDING PROFESSION

I. Importance of standards to the welding industry (HO 1.1)

   A. As the welding industry grew, it became evident that standards were needed for manufactured items used in welding. Standards were also needed to test the qualifications of welders.

   B. In 1936, the Committee on Standard Qualification Procedures issued its first report to the American Welding Society calling for a general qualification standard for procedures and performances of welders.

   C. As the needs presented themselves, other standards were issued by such groups as the American Iron and Steel Institute, American Petroleum Institute, Society of Automotive Engineers and the Aluminum Association.

II. Employment

   A. Three out of five welders manufacture durable goods ranging from trucks and ships to smaller parts for consumer goods.

   B. Most of the remaining welders work in metal products repair or construction of bridges, buildings and pipelines.

   C. While job openings vary geographically, most welders are concentrated in manufacturing centers such as the Great Lakes, Sunbelt and western states.

   D. Few welders use only their welding ability on the job. Welders need to remain flexible to adapt to technological change and local market conditions.

      1. Advances in robotics, machine-sensing capabilities and computer-aided manufacturing

      2. Increased use of high-strength composite materials and improved plastics

      3. Related jobs which are sometimes combined with a welder's duties

         a. Blacksmiths and forge shop workers

         b. All-round machinists, machine tool operators and tool-and-die makers

         c. Millwrights

         d. Sheet-metal workers

         e. Boilermakers

         f. Metal sculptors

E. Welders can belong to a variety of different unions.

   1. International Association of Machinists and Aerospace Workers

   2. International Brotherhood of Boilermakers, Iron Shipbuilders, Blacksmiths, Forgers and Helpers

   3. International Union, United Automobile, Aerospace and Agricultural Implement Workers of America

   4. United Association of Journeymen and Apprentices of the Plumbing and Pipe Fitting Industry of the United States and Canada

   5. United Electrical, Radio and Machine Workers of America

III. Job opportunities for welders

   A. Employment for welders is expected to increase as fast as the average for all occupations through the 1990s.

      1. Welding skills are applicable in occupations such as precision production, craft, repair, construction and manufacturing.
      2. Welders and flame-cutters, however, are vulnerable to periodic layoffs for factory retooling.

   B. New welders will continue to be needed to replace others who move to different occupations or retire.

   C. Many production lines will use robotic welding systems, but highly skilled welders are not expected to be affected by automation in the near future. Additional welding-related jobs exist in the planning and programming of robotic systems.

   D. Earnings for welders will continue to be above the average for non-supervisory occupations.

      1. In 1982, full-time welders earned a median weekly salary of $334 a week.

      2. The middle 50 percent range was $250-$425 a week in 1982.

IV. Personal requirements for a successful welder (TM 1.1)

   A. Manual dexterity, good eyesight and good eye-hand coordination

   B. Ability to concentrate on detailed work for long periods

   C. Physical ability to bend, stoop and work in awkward positions

   D. Basic skills in math and blueprint reading

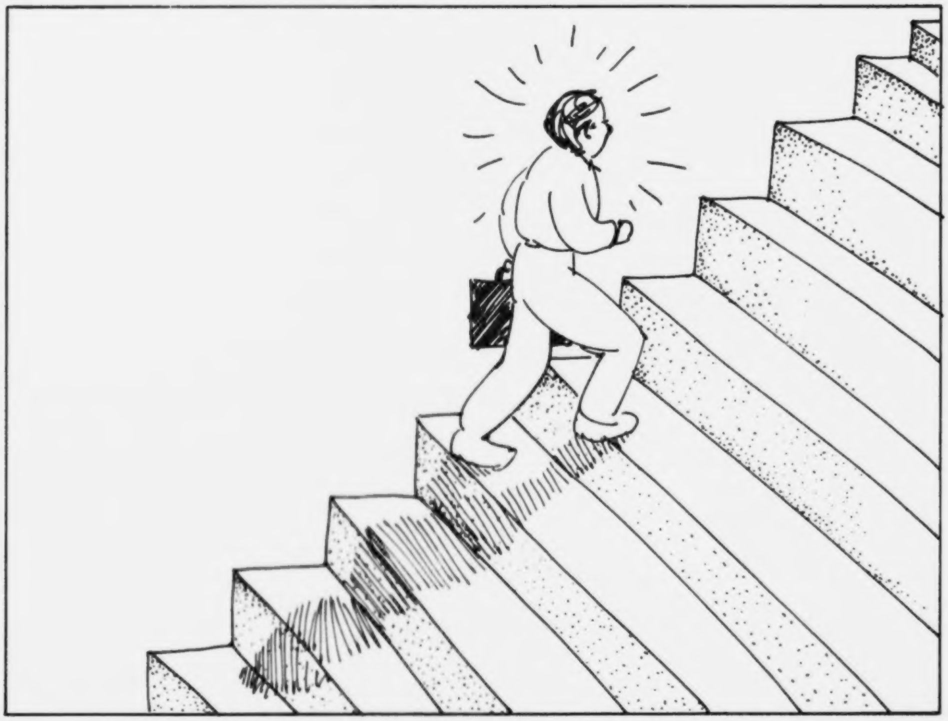
   E. Basic skills in welding processes

   F. Basic skills in metallurgy (properties of metals)

   G. A good attitude toward the job and the employer

ATTITUDES THAT PROMOTE JOB ADVANCEMENT

- Enthusiasm and interest
- Dedication and dependability
- Alertness, quickness of mind
- Honesty and integrity
- Desire to work
- Ability to work with others
- Desire to improve yourself
- Belief in a day's work for a day's pay
- Safety consciousness
- Willingness to start at the ground level



PROFESSIONAL ORGANIZATIONS AND ABBREVIATIONS

AA
Aluminum Association
818 Connecticut N.W.
Washington, DC 20006
(202) 862-5100

AISI
American Iron and Steel Institute
1000 16th St. N.W.
Washington, DC 20036
(202) 452-7100

ANSI
American National Standards Institute
1430 Broadway
New York, NY 10018
(212) 354-3300

API
American Petroleum Institute
2101 L St. N.W.
Washington, DC 20037
(202) 457-7000

ASM
American Society for Metals
Route 87
Metals Park, OH 44073
(216) 338-5151

ASME
American Society of Mechanical Engineers
345 E. 47th St.
New York, NY 10017
(212) 705-7800
(800) 843-2763 (Orders, publ. info.)

AWS
American Welding Society
550 N.W. LeJeune Road
Miami, FL 33126
(800) 443-9353
(305) 443-9353

NSC
National Safety Council
444 N. Michigan Ave.
Chicago, IL 60611
(312) 527-4800

NWSA
National Welding Supply Association
1900 Arch St.
Philadelphia, PA 19103
(215) 564-3484

SAE
Society of Automotive Engineers
400 Commonwealth Dr.
Warrendale, PA 15096
(412) 776-4841

SME
Society of Manufacturing Engineers
One SME Drive
P.O. Box 930
Dearborn, MI 48128
(313) 271-1500

MODULE: BASIC WELDING SKILLS

UNIT I: ORIENTATION

LESSON 2: WELDING AND CUTTING PROCESSES

I. Terms and definitions

A. Acetylene--an explosive hydrocarbon gas used as a fuel for soldering, welding and cutting metals. It has a characteristically unpleasant odor and is colorless.

B. Arc--in electric welding, a visible flash of electricity which spans the gap separating the work lead (electrode) and the work (ground)

C. Base metal--any metal to be welded or cut

D. Capillary attraction--the force that causes a liquid to raise vertically against a solid, such as water on a clean glass

E. Electrode--the part of the electric arc welding circuit through which electrical current passes between the arc and electrode holder; may or may not be consumed during the process. Consumable electrodes are bare, composite, covered, emissive, flux-cored, lightly coated or metal. Non-consumable electrodes are carbon, tungsten or metal.

F. Ferrous--any metal alloy with iron as its primary ingredient

G. Filler metal--the additional metal needed when some welded, brazed or soldered joints are being made

H. Flux--in welding, promotes metal fusing by helping remove potentially harmful oxides; prevents and eliminates many harmful impurities which can weaken welds

I. Fusion--the joining of metals by melting them together with or without filler metal

J. High-purity welds--welds which are not contaminated with pores, pits or slag

K. Hydrocarbon--any organic compound that contains only carbon and hydrogen

L. Hydrogen--(H) a colorless, highly flammable gas used in torches which produces a very clean but low-temperature flame

M. Inert gas--under normal welding conditions, does not chemically combine with either filler metals or base metals. Argon and helium are the most common.

N. Ionized gas--a gas which conducts electricity

O. Melting point--point at which a solid becomes a liquid

P. Metal deposition--process of adding filler metal to a weld or welding puddle

Q. Natural gas--a mixture of hydrocarbon gases occurring with petroleum deposits; used as a fuel

R. Nonferrous--alloys containing a metal other than iron

S. Oxygen--colorless, odorless, tasteless gas which combines with most elements and is required for nearly all combustive processes

T. Plasma--electrically neutral, highly ionized gas composed of ions, electrons and neutral particles

U. Propane--liquified petroleum gas which is most often used for jobs requiring a flame heat of less than 1000F

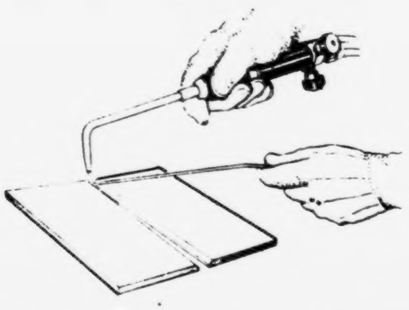
V. Scavenger--substance added to a mixture to remove impurities or to counteract undesirable effects of other ingredients

W. Welding--process of joining two metals together by heating them with a torch or an electric arc; sometimes utilizes a filler metal

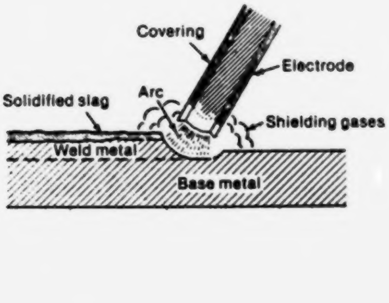
X. Workpiece--prior to becoming a finished part, the ferrous or nonferrous base metal to be welded or cut on

II. Welding processes and functions (HO 1.1)

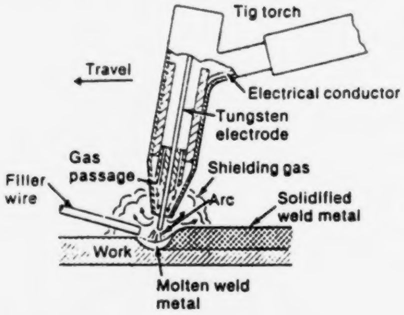
A. OAW: Oxy-acetylene welding joins metals by heating them to melting point and allowing the melted portions to flow together--with or without a filler metal.



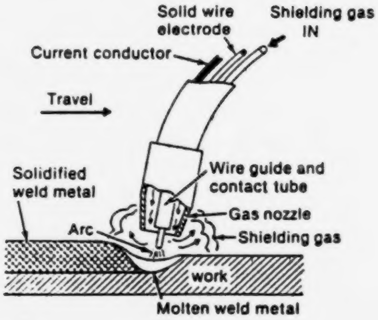
B. SMAW: Shielded metal arc welding joins metals with heat from an electric arc between a base metal and a flux-covered electrode. This process is referred to as "stick" welding.



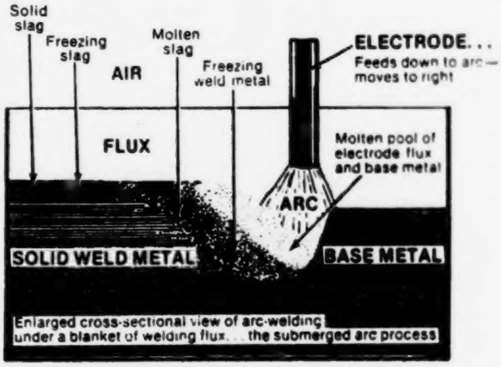
C. GTAW: Gas tungsten arc welding joins metals by heating with an arc between a workpiece and a tungsten electrode in the presence of an inert, shielding gas. This process is referred to as "TIG" welding.


Tig torch
Travel
Electrical conductor
Tungsten electrode
Gas passage
Shielding gas
Filler wire
Arc
Solidified weld metal
Work
Molten weld metal

D. GMAW: Gas metal arc welding joins metals by heating with an arc between a workpiece and a consumable electrode in the form of a continuously-fed wire in the presence of an inert, shielding gas. This process is referred to as "MIG" welding.


Solid wire electrode
Shielding gas IN
Current conductor
Travel
Solidified weld metal
Wire guide and contact tube
Gas nozzle
Arc
Shielding gas
work
Molten weld metal

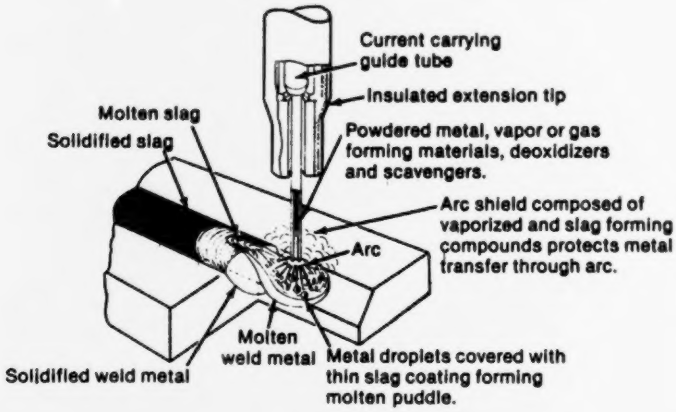
E. SAW: Submerged arc welding joins metals by heating with an arc between a workpiece and a bare metal electrode continuously fed into a covering shield of granulated flux.


Solid slag
Freezing slag
AIR
Molten slag
Freezing weld metal
ELECTRODE. . .
Feeds down to arc — moves to right
FLUX
Molten pool of electrode flux and base metal
ARC
SOLID WELD METAL
BASE METAL
Enlarged cross-sectional view of arc-welding under a blanket of welding flux. . . the submerged arc process

F. FCAW

1. Flux-cored arc welding joins metals by heating with an arc between a workpiece and a consumable electrode continuously-fed in the presence of a shielding flux contained inside the electrode.

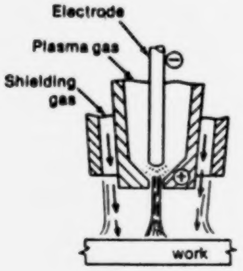
2. There is also a dual-shielded process in flux-cored arc welding that uses shielding from both the electrode flux and a shielding gas.


Current carrying guide tube
Insulated extension tip
Molten slag
Solidified slag
Powdered metal, vapor or gas forming materials, deoxidizers and scavengers.
Arc shield composed of vaporized and slag forming compounds protects metal transfer through arc.
Arc
Molten weld metal
Solidified weld metal
Metal droplets covered with thin slag coating forming molten puddle.

G. PAW

1. Plasma arc welding joins metals by heating with a restricted arc between an electrode and a workpiece or a constricting nozzle with shielding usually provided by a hot, ionized gas projected from the nozzle as a plasma jet.

2. Plasma arc welding sometimes employs an additional shielding gas, and the principle of the high-energy density of the plasma jet is also used effectively in plasma arc cutting (PAC).


Electrode
Plasma gas
Shielding gas
work

III. Braze welding and brazing

A. Brazing: general group of welding processes that use a nonferrous filler metal with a melting point over 800F but lower than the base metals' melting point. Distribution of the filler metal is achieved through capillary attraction.

B. Braze welding: general group of welding processes that use a nonferrous filler metal with a melting point over 800F but lower than the base metals' melting point. Distribution of the filler metal is achieved through weld design, not by capillary action.

IV. Cutting processes and functions (HO 2.2)

   A. OFC: Oxygen fuel cutting is a general group of cutting processes that use oxygen and other selected gases that form a chemical reaction with a base metal at elevated temperatures to make a cut.

   B. AC: Arc cutting, a general group of cutting processes, uses the heat of an arc to make a cut.

      1. CAC: carbon-arc cutting

      2. PAC: plasma-arc cutting

V. Importance of welding and cutting processes

   A. Oxy-acetylene welding and cutting

      1. The first widely used welding and cutting process

      2. Still used frequently because equipment is readily portable and handy for maintenance welding in industry and agriculture

   NOTE: Students planning a welding career will benefit from learning oxy-acetylene welding and cutting because it helps develop eye-and-hand coordination and the manual dexterity required to perform many other welding processes properly.

   B. Shielded metal arc welding (SMAW)

      1. The first widely used arc-welding process

      2. Popular because its rate of metal deposition is higher than that of oxy-acetylene

      3. Frequently used because equipment is readily portable, adaptable to many welding applications, relatively inexpensive and can be used in adverse weather conditions

   C. Gas tungsten arc welding (GTAW): Developed to answer the needs for high-purity welds where control of heat must be precise to accomplish critical applications with corrosion-resistant and other difficult-to-weld metals

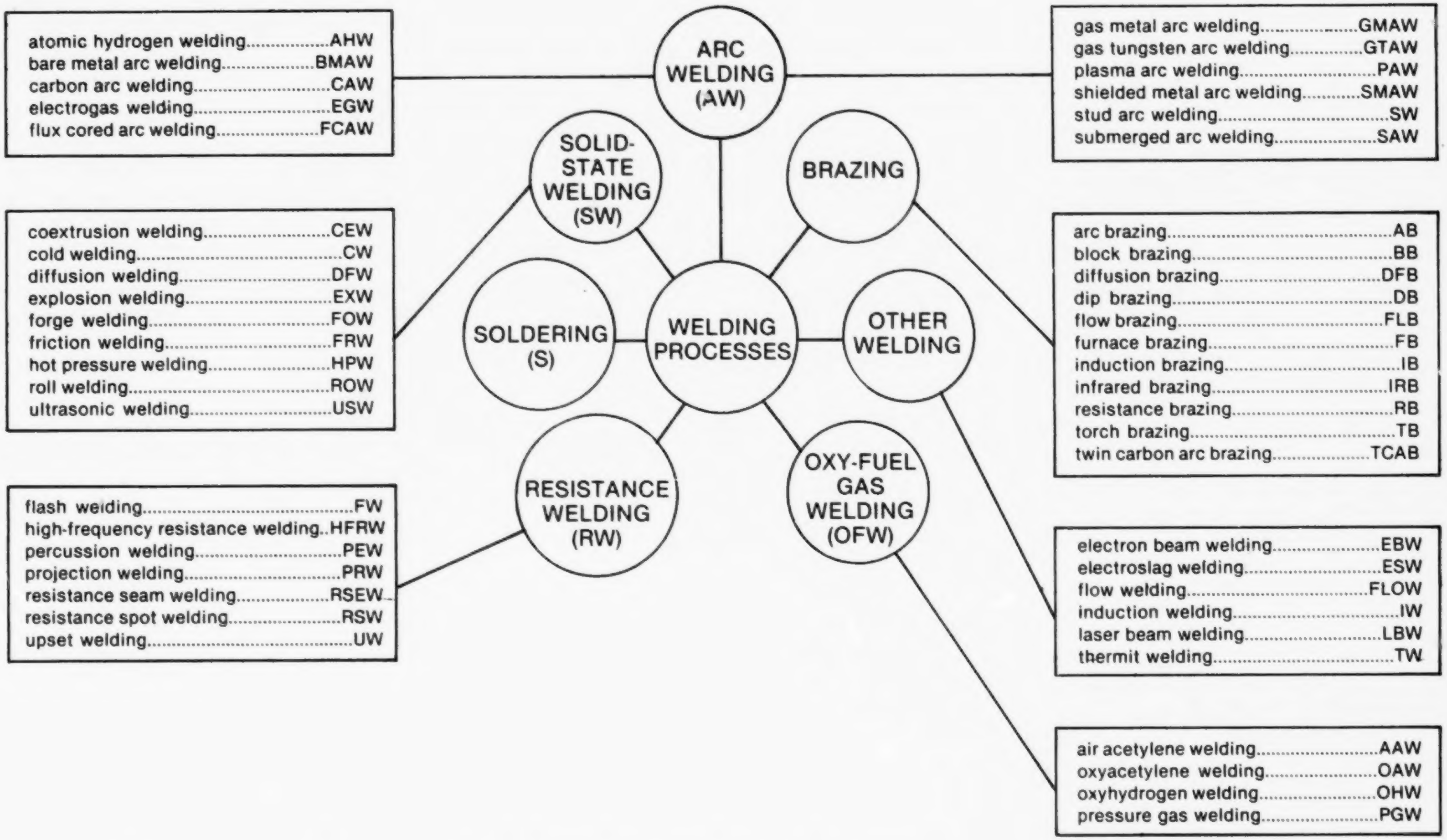
   D. Gas metal arc welding (GMAW)

      1. Developed to answer the needs for high productivity in production-line manufacturing

      2. Popular because of its adaptability to all kinds of metals and reduced distortion factor, which produces high-quality welds

   NOTE: Because of its versatility, GMAW welding is popular with semi-automatic, automatic and robotic applications.

WELDING PROCESSES


ARC WELDING (AW)
SOLID-STATE WELDING (SW)
BRAZING
SOLDERING (S)
WELDING PROCESSES
OTHER WELDING
RESISTANCE WELDING (RW)
OXY-FUEL GAS WELDING (OFW)

atomic hydrogen welding	AHW
bare metal arc welding	BMAW
carbon arc welding	CAW
electrogas welding	EGW
flux cored arc welding	FCAW

gas metal arc welding	GMAW
gas tungsten arc welding	GTAW
plasma arc welding	PAW
shielded metal arc welding	SMAW
stud arc welding	SW
submerged arc welding	SAW

coextrusion welding	CEW
cold welding	CW
diffusion welding	DFW
explosion welding	EXW
forge welding	FOW
friction welding	FRW
hot pressure welding	HPW
roll welding	ROW
ultrasonic welding	USW

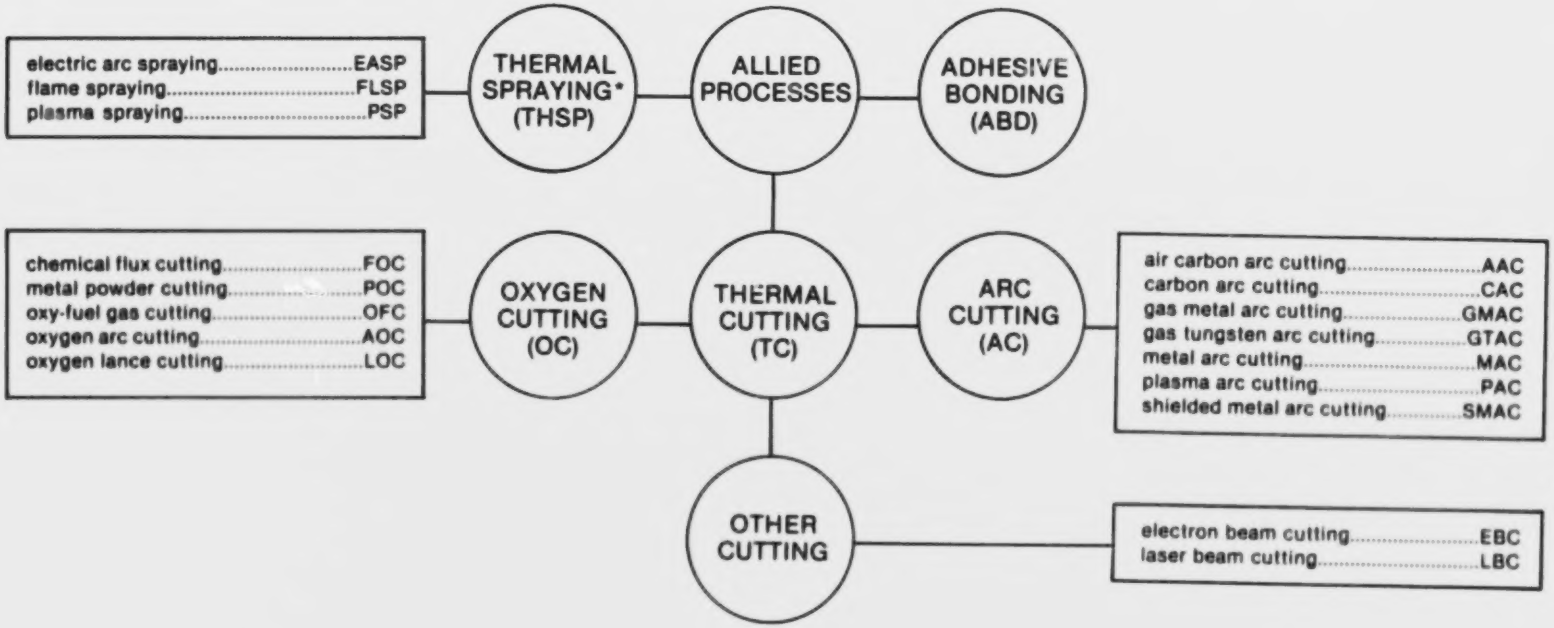
arc brazing	AB
block brazing	BB
diffusion brazing	DFB
dip brazing	DB
flow brazing	FLB
furnace brazing	FB
induction brazing	IB
infrared brazing	IRB
resistance brazing	RB
torch brazing	TB
twin carbon arc brazing	TCAB

flash welding	FW
high-frequency resistance welding	HFRW
percussion welding	PEW
projection welding	PRW
resistance seam welding	RSEW
resistance spot welding	RSW
upset welding	UW

electron beam welding	EBW
electroslag welding	ESW
flow welding	FLOW
induction welding	IW
laser beam welding	LBW
thermit welding	TW

air acetylene welding	AAW
oxyacetylene welding	OAW
oxyhydrogen welding	OHW
pressure gas welding	PGW

ALLIED PROCESSES


THERMAL SPRAYING* (THSP)
ALLIED PROCESSES
ADHESIVE BONDING (ABD)
OXYGEN CUTTING (OC)
THERMAL CUTTING (TC)
ARC CUTTING (AC)
OTHER CUTTING

electric arc spraying	EASP
flame spraying	FLSP
plasma spraying	PSP

chemical flux cutting	FOC
metal powder cutting	POC
oxy-fuel gas cutting	OFC
oxygen arc cutting	AOC
oxygen lance cutting	LOC

air carbon arc cutting	AAC
carbon arc cutting	CAC
gas metal arc cutting	GMAC
gas tungsten arc cutting	GTAC
metal arc cutting	MAC
plasma arc cutting	PAC
shielded metal arc cutting	SMAC

electron beam cutting	EBC
laser beam cutting	LBC

*Sometimes a welding process

MODULE: BASIC WELDING SKILLS

UNIT I: ORIENTATION

UNIT TEST

Match the term on the right with its definition on the left.

____ 1. The joining of metals by melting them together (with or without filler metal)

____ 2. Additional metal needed when some welded, brazed or soldered joints are being made

____ 3. An explosive hydrocarbon gas used as a fuel for soldering, welding and cutting metals

____ 4. The process of joining two metals together by heating them with a torch or an electric arc

____ 5. Designates code numbers for steel alloys; also stands for American Iron and Steel Institute

____ 6. Any metal to be welded or cut

____ 7. Ferrous or nonferrous base metal to be welded or cut on prior to becoming a finished part

____ 8. The part of the electric arc welding circuit through which electrical current passes between the arc and electrode holder

____ 9. Colorless, odorless, tasteless gas which combines with most elements and is required for nearly all combustive processes

____ 10. Any metal alloy with iron as its primary ingredient

____ 11. Under normal welding conditions, does not chemically combine with either the filler or base metal

____ 12. Organized in 1919; successfully set uniform standards for welding performance

____ 13. Alloys containing a metal other than iron

____ 14. In electric welding, a visible flash of electricity which spans the gap separating the work lead and the work

____ 15. American National Standards Institute

a. Acetylene

b. AISI

c. ANSI

d. Arc

e. AWS

ab. Base metal

ac. Electrode

ad. Ferrous

ae. Filler metal

bc. Fusion

bd. Inert gas

be. Non ferrous

cd. Oxygen

ce. Welding

de. Workpiece

Choose the option which best answers the question or completes the statement.

____ 16. Three out of five employed welders manufacture durable goods consisting of ____ .

a. Trucks
b. Ships
c. Smaller parts for consumer goods
d. All of the above

____ 17. Which manufacturing center is not considered a highly concentrated welder area?

a. Great Lakes
b. Southwestern states
c. Sunbelt
d. Western states

____ 18. Welding skills are applicable in occupations such as _____ .

a. Construction
b. Repair
c. Manufacturing
d. All of the above

____ 19. Which personal requirement is not needed to be a successful welder?

a. Basic math and blueprint reading skill
b. Basic machine shop skill
c. Basic welding skill
d. Basic metallurgy knowledge

____ 20. Which of the following is not required to be a successful welder?

a. Ability to stand on your head
b. Ability to bend
c. Ability to stoop
d. Ability to work in awkward positions

____ 21. Which attitude promotes job advancement?

a. A day's work for a half day's pay
b. A half day's work for a day's pay
c. A day's work for a day's pay
d. None of the above

ANSWERS TO UNIT TEST

1. bc
2. ae
3. a
4. ce
5. b
6. ab
7. de
8. ac
9. cd
10. ad
11. bd
12. e
13. be
14. d
15. c
16. d
17. b
18. d
19. b
20. a
21. c

MODULE: BASIC WELDING SKILLS

UNIT II: PERSONAL SAFETY

UNIT OBJECTIVE

Upon completion of this unit, the student should be able to demonstrate safe work habits in the welding profession by protecting himself or herself from unsafe conditions. This knowledge will be evidenced by completing the unit test to specified score.

SPECIFIC OBJECTIVES

After completion of the lessons in this unit, the student will be able to:

1.1 Match terms and definitions related to welding safety and first aid.

1.2 Complete statements concerning good housekeeping rules.

1.3 Identify OSHA employer and employee expectations.

1.4 Complete statements concerning rules for personal safety.

1.5 Complete statements concerning personal physical and hygiene requirements.

2.1 Identify true statements concerning eye safety.

3.1 Select factors which contribute to back injury.

3.2 Complete statements about safe lifting.

MODULE: BASIC WELDING SKILLS

UNIT II: PERSONAL SAFETY

CONTENTS OF THIS UNIT

A. Objective sheet

B. References

C. Notes to the instructor

D. Lesson plans

1. Lesson 1: ORIENTATION

    a. Information outline

    b. Assignment sheet

        AS 1.1: Student safety pledge for vocational welding

2. Lesson 2: EYE SAFETY

    a. Information outline

    b. Transparency master

        TM 2.1: Recommended eye and face protectors

    c. Assignment sheet

        AS 2.1: Eye safety when welding

    d. Answers to assignment sheet

3. Lesson 3: LIFTING

    a. Information outline

    b. Transparency masters

        TM 3.1: Injury causes
        TM 3.2: Safe lifting steps

E. Unit test

F. Answers to unit test

REFERENCES

A. Books

1. Guza, Michael, et al. Welding Glossary of Key Words. White Bear Lake, Minn.: Minnesota Instructional Materials Center, 1973.

2. Sacks, J. Raymond. Welding Principles and Practices. Peoria, Ill.: Charles A. Bennett Co., Inc., 1976.

3. Occupational Outlook Handbook, 1984-85 ed. Washington, D.C.: U.S. Department of Labor, Bureau of Labor Statistics, 1984.

4. Pocket Welding Guide. Troy, Ohio: Hobart Brothers Company, 1980.

5. The Metal Craftsman's Handbook. Athens, Geo.: American Association for Vocational Instructional Materials, 1980.

6. The Procedure Handbook of Arc Welding. Cleveland: The Lincoln Electric Company, 1973.

7. Welding Procedure and Performance Qualification. Miami: American Welding Society, 1977.

B. Curriculum guide

1. Fortney, Clarence, and Mike Gregory. Introduction to Welding. Stillwater, Okla.: Mid-America Vocational Curriculum Consortium, Inc., 1984.

NOTES TO THE INSTRUCTOR

A. Suggested approaches to teaching this unit

1. Have students and parents sign emergency treatment clearance forms.

2. Contact an area Red Cross chapter for first-aid teaching material such as the Basic Aid Training Kit (BAT). This illustrated kit includes approved first-aid procedures for the class.

3. Invite a Red Cross representative to speak to the class about safety.

4. Note that protective clothing will be covered in Unit IV: Shop Safety.

MODULE: BASIC WELDING SKILLS

UNIT II: PERSONAL SAFETY

LESSON 1: ORIENTATION

I. Terms and definitions

   A. Accident--any suddenly occurring, unintentional event that causes personal injury or property damage

   B. Arc burn--a burn on the exterior membrane of the eye caused by exposing the naked eye to ultraviolet and infrared rays in the flash of an electric arc; also, the exposure of improperly covered body areas to the flash of an electric arc

      CAUTION: Major arc burns can cause blindness! Develop the habit of wearing the correct shade of protective lens when working with any welding process.

   C. Combustibles--materials or liquids that catch fire easily

   D. First aid--immediate, temporary care given the victim of an accident or sudden illness until the service of a trained medical professional can be obtained

   E. Hygiene--the science of good health and its maintenance, including sanitary practices and cleanliness

   F. OSHA--Occupational Safety and Health Administration; federal agency designed to ensure safe, sanitary working conditions for employees

   G. Safety--state or condition of being safe; freedom from danger, risk or injury

   H. Tetanus--an acute, infectious disease that usually enters the body through cuts or wounds; characterized by spasms or rigidity in some voluntary muscles; frequently referred to as lockjaw

II. Good housekeeping rules

   A. Arrange machinery and equipment to permit safe, efficient work practices and ease in cleaning.

   B. Store materials and supplies in proper places.

   C. Store tools and accessories safely in cabinets, on racks or other suitable devices.

   D. Keep working areas and work benches clear and free of debris and other hazards.

   E. Keep floors clean and free from obstructions or slippery substances.

   F. Keep aisles, traffic areas and exits free of materials and debris.

   G. Dispose of combustible materials properly or store them in approved containers.

   H. Store oily rags in self-closing or spring-lid metal containers.

I. Keep sufficient brooms, brushes and other housekeeping equipment readily available.

III. OSHA employer requirements

A. Provide a hazard-free workplace and comply with occupational safety and health standards.

B. Inspect job sites to assure they meet safety standards.

C. Use properly color-coded signs to warn of danger.

D. Keep required records of work-related injuries and post an annual summary in February of each year.

E. Report to OSHA within 48 hours any accident that is fatal or hospitalizes five or more workers.

F. Post in a prominent place a poster such as OSHA's #2203 informing workers of rights and responsibilities.

IV. OSHA employee expectations

A. Read the OSHA poster and comply with its standards.

B. Follow employer safety and health rules and wear prescribed clothing or protective equipment on the job.

C. Report hazardous conditions to a supervisor.

D. Report all job-related injuries to a supervisor and seek prompt treatment if required.

E. Report to OSHA in a responsible manner any hazardous working situations that you feel the employer has not attended to properly.

V. Rules for personal safety

A. Wear shop clothing appropriate to the instructional activity being performed. Do not wear greasy clothing.

B. Confine long hair before operating rotating equipment.

C. Remove ties when working around machine tools or rotating equipment.

D. Remove rings and other jewelry when working in the shop. Avoid wearing safety glasses that have wire frames.

E. Conduct yourself in a manner conducive to safe shop practices.

F. Do not smoke in restricted areas and do not carry a butane or propane lighter around any welding or cutting activity.

VI. Personal physical and hygiene requirements

A. Take a bath or shower daily.

NOTE: This should be a matter of personal pride and a matter of habit, but beyond that, it's a responsibility to fellow workers or classmates.

B. Stay in good physical condition because this also promotes good psychological health.

C. Do not drink alcoholic beverages or use drugs on the job. Don't show up for work with a hangover.

CAUTION: Even at the hangover stage, alcohol impairs judgment and endangers co-workers. Drugs are both physically and psychologically damaging.

D. Constantly pay close attention--the majority of accidents happen to beginners in the first few months of work.

STUDENT SAFETY PLEDGE FOR VOCATIONAL WELDING

________________________________, who is enrolled in vocational welding studies at__________ ____________________, will operate machines and equipment as a part of the training program. This activity requires the written permission of parent(s) or guardian(s).

It is understood that each student will be given proper instructions in the safe use of machines and equipment before being allowed to operate them alone. Further, the student will be instructed in rules and regulations and safety requirements for classroom and shop activities. The student must assume responsibility for conducting himself/herself in a safe manner. It is requested that the student sign the following student safety pledge.

I PROMISE TO ABIDE BY ALL SAFETY RULES FOR THE SHOP AS FOLLOWS:

1. To use hand tools and power tools only after proper instruction and only with the instructor's permission
2. To use all tools and equipment only for their intended purposes and to wear safety glasses at all times in the shop area
3. To exhibit a concern for tools and equipment by returning them to proper storage areas after use
4. To contribute to good housekeeping requirements and to keep the shop area clean and safe
5. To abide by all fire regulations and to respect no smoking signs or areas
6. To avoid horseplay at all times
7. To follow all rules and regulations of the school

I WILL REPORT ALL ACCIDENTS AND UNSAFE WORKING CONDITIONS TO THE INSTRUCTOR IMMEDIATELY.

Date __________ Student's signature _____________

As parent(s) or guardian of____________________________________, I hereby give consent for my son/daughter to operate all machines and equipment necessary for carrying out the requirements of the welding course in which he/she is enrolled. (Parent or guardian signature is not required for students of legal age.)

Date ______ Parent/guardian signature ______________

(Parents are cordially invited to visit the school and inspect the welding program at any convenient time.)

MODULE: BASIC WELDING SKILLS

UNIT II: PERSONAL SAFETY

LESSON 2: EYE SAFETY

I. Eye safety (TM 2.1)

A. Wear safety glasses at all times in the welding shop.

B. Wear safety glasses and a face shield when grinding, chipping, cutting, or shaping metal with any kind of power tool.

C. Contact lens wearers should check with their doctor to see if the type of lens requires any special precautions in the work place.

D. Do not wear eyeglasses with plastic-coated lenses when welding or cutting.

E. Select the proper lens shade for the welding or cutting activity; make sure the lens is not chipped, cracked or damaged.

F. Remember that lens shade numbers are not additive--a #8 and a #6 will not give the same density as a #14 lens, so don't mix lenses.

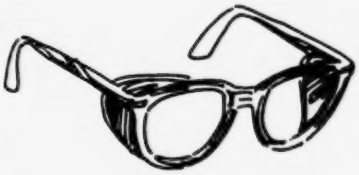
G. Wear welding goggles or a welding hood with the proper lens shade for all welding and cutting activity. See the chart that follows.

LENS SHADE SELECTOR

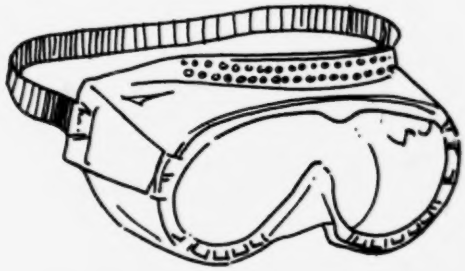
Type of operation	Shade no.
Soldering	2
Torch brazing	3 or 4
Oxygen cutting	
0-1 inch	3 or 4
1-6 inches	3 or 5
6 inches and over	5 or 6
Gas welding	
0-1/8 inch	4 or 5
1/8 inch to 1/2	5 or 6
1/2 inch and over	6 or 8
Shielded metal arc welding	
1/16, 3/32, 1/8, 5/32 inch electrodes	9-14
Arc cutting	12-14
Gas metal arc welding	9-14
Gas tungsten arc welding	
Nonferrous, gas metal arc welding	
1/16, 3/32, 1/8, 5/32 inch electrodes	9-14
Gas tungsten arc welding (ferrous), gas metal arc welding (ferrous)	
1/16, 3/32, 1/8, 5/32 inch electrodes	9-14

TM 2.1

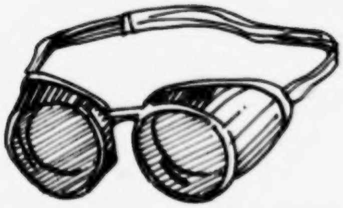
RECOMMENDED EYE AND FACE PROTECTORS



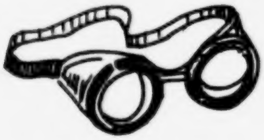
Safety Glasses



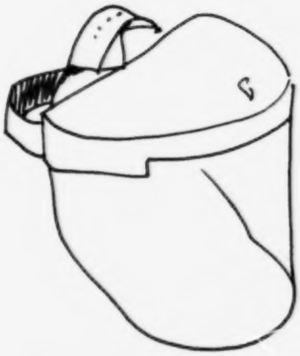
Flexible Goggles



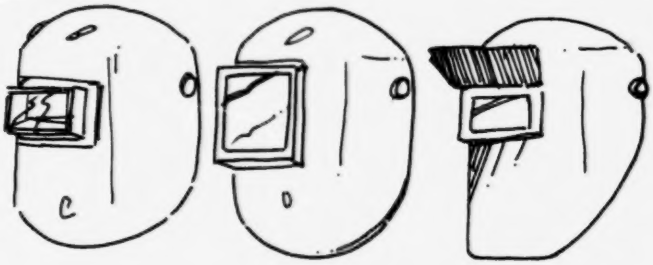
Cutting Goggles



Chipping Goggles



Face Shield



Welding Helmets

EYE SAFETY WHEN WELDING

Complete statements concerning eye safety by circling the word(s) that best completes each statement.

1. Wear (safety glasses) (a welding helmet) at all times in the welding shop.
2. Wear (safety glasses and a face shield) (a face shield) when grinding, chipping, cutting or shaping metal with any kind of power tool.
3. If you wear (glasses) (contact lenses), check with your doctor to see if the type of lens requires any special precautions in the work place.
4. Select the proper lens shade for the welding or cutting activity and make sure the lens is not (chipped, cracked or damaged) (too dark).
5. Do not wear (amber-colored) (plastic-coated) lenses for welding or cutting.
6. Remember that lens shade numbers are not additive. In other words, a #8 and a #6 will not give the same density as a #14 lens, so (don't mix lenses) (mix two darker shades).
7. Wear welding goggles or a welding hood with the proper lens shade for all (welding and cutting activity) (shop activity).

ANSWERS TO ASSIGNMENT SHEET 2.1

1. Safety glasses
2. Safety glasses and a face shield
3. Contact lenses
4. Chipped, cracked, or damaged
5. Plastic-coated
6. Don't mix lenses
7. Welding and cutting activity

MODULE: BASIC WELDING SKILLS

UNIT II: PERSONAL SAFETY

LESSON 3: LIFTING

I. Factors contributing to back injuries (TM 3.1)

   A. Weight: This usually is the result of overestimating physical abilities and trying to lift more weight than one can handle.

   B. Size: This is usually the result of moving an object that may be within one's weight capacity but is too long, high or wide to lift safely.

   C. Shape: This is usually the result of moving an object that may be within one's weight capacity but has a cylindrical or other odd shape that makes safe lifting difficult.

   D. Obstructions: These are usually the result of stacking materials so high that vision is limited and obstructions in the pathway cannot be seen.

   E. Improper position: This usually happens when twisting or turning into an awkward position when lifting.

   F. Improper storage: This is usually the result of a strain caused by not storing heavy objects at least 12" off the floor.

   G. Improper reaching: This usually happens when using chairs or boxes carelessly to reach from, instead of safely using a ladder.

II. Steps in lifting safely (TM 3.2)

   A. Approach the load; size up its weight, size and shape; consider your physical ability to handle it.

   B. Place feet close to the object to be lifted and keep them 8-12 inches apart for good balance.

   C. Bend your knees to a comfortable degree; get a good hand hold; use both leg and back muscles to begin the lift.

   D. Lift the load straight up, smoothly and evenly, while pushing with your legs; keep the load as close as possible to your body.

   E. Lift the load into carrying position, making no turning or twisting movements until the lift is completed.

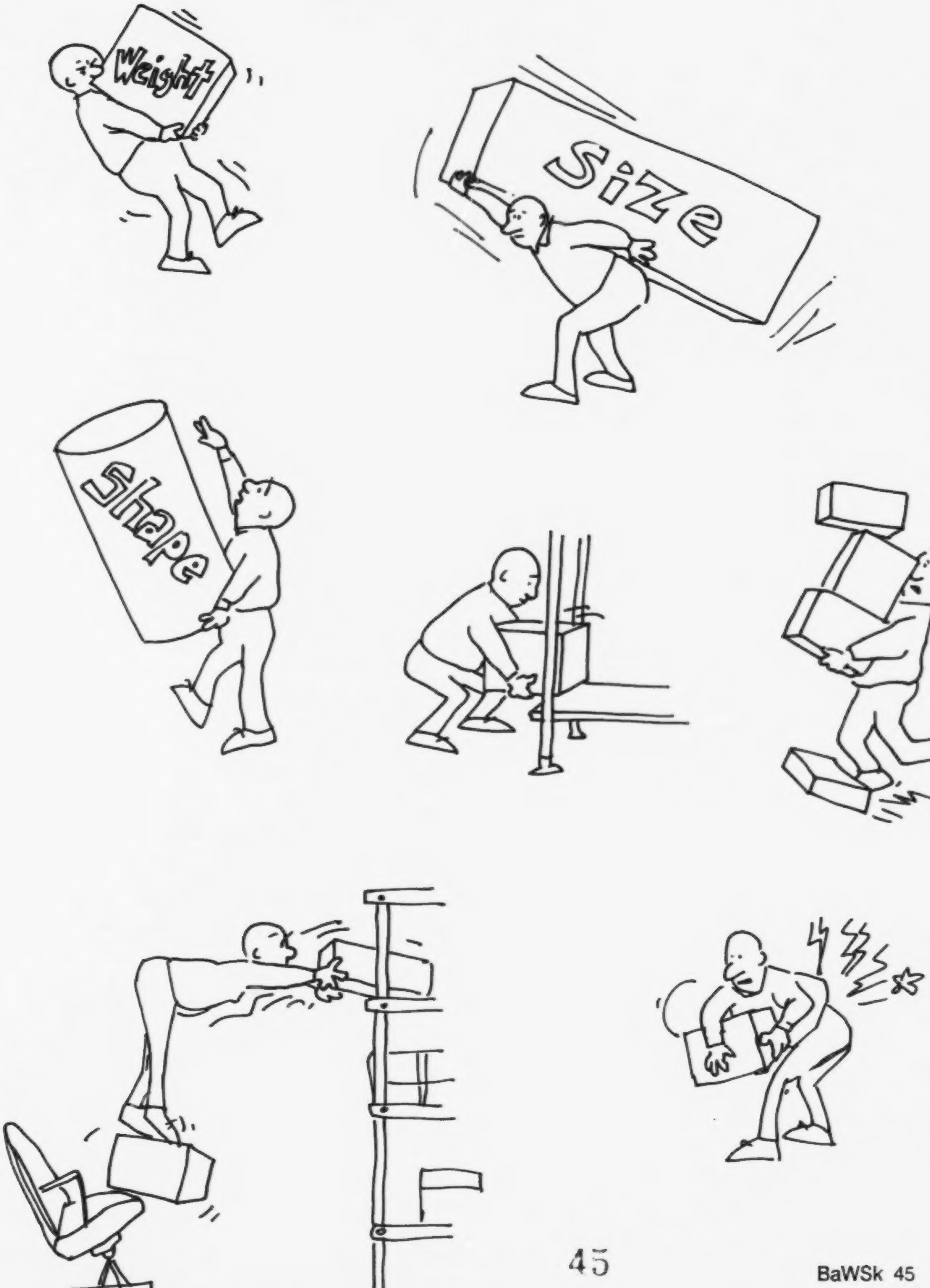
   F. Turn your body with changes of foot position while you visually check the path of travel to make sure it is clear.

   G. Set the load down by using leg and back muscles together; slowly lower the load by bending your knees; release your grip only after the load is securely positioned.

H. When lifting or carrying with another worker, make sure the load is equally distributed. Carry long objects at the same level and on the same side of the body.

TM 3.1

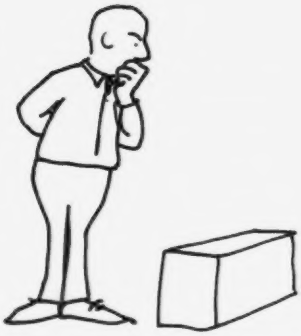
INJURY CAUSES


Weight
Size
Shape

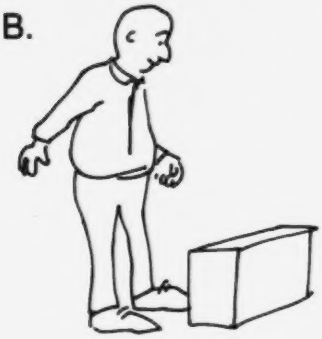
TM 3.2

SAFE LIFTING TIPS

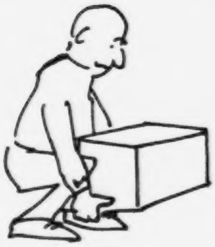
A.



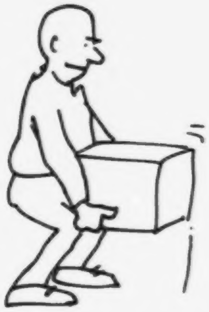
B.



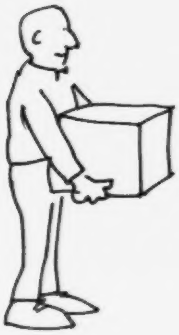
C.



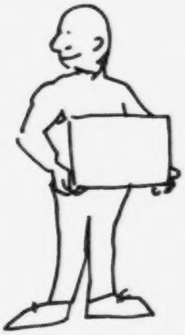
D.



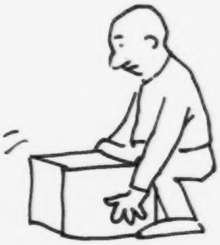
E.



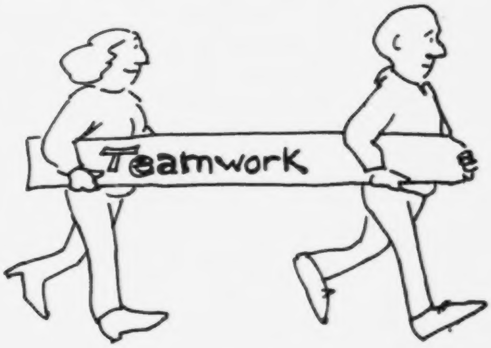
F.



G.



H.



MODULE: BASIC WELDING SKILLS

UNIT II: PERSONAL SAFETY

UNIT TEST

Match the description or definition on the left with the appropriate term on the right.

____ 1. Materials or liquids that catch fire easily

____ 2. Occupational Safety and Health Administration; federal agency designed to ensure safe, sanitary working conditions for employees

____ 3. The science of good health and its maintenance, including sanitary practices and cleanliness

____ 4. An acute, infectious disease that usually enters the body through cuts or wounds; characterized by spasms or rigidity in some voluntary muscles; frequently referred to as lockjaw

____ 5. Any suddenly occurring, unintentional event that causes personal injury or property damage

____ 6. Immediate, temporary care given the victim of an accident or sudden illness until the service of a trained medical professional can be obtained

____ 7. A burn on the exterior membrane of the eye caused by exposing the naked eye to ultraviolet and infrared rays in the flash of an electric arc

____ 8. Provide a hazard-free workplace and comply with occupational safety and health standards, inspect job sites to assure they meet safety standards, use properly color-coded signs to warn of danger

____ 9. State or condition of being safe; freedom from danger, risk or injury

____ 10. Read the OSHA poster and comply with its standards, follow safety and health rules and wear prescribed clothing or protective equipment on the job

a. Accident
b. Arc burn
c. Combustibles
d. First aid
e. Hygiene
ab. OSHA
ac. OSHA employee expectations
ad. OSHA employer expectations
ae. Safety
bc. Tetanus

Select the answer which best completes the statement or answers the question.

____ 11. Which rule is not a good welding safety housekeeping rule?

a. Arrange equipment to permit safe, efficient work practices and ease in cleaning.
b. Store oily rags in a well-ventilated, open can.
c. Keep floors clean and free from obstructions or slippery substances.
d. Keep sufficient housekeeping materials readily available.

____ 12. Which of the following is not a rule for personal safety?

a. Wear shop clothing appropriate to the instructional activity being performed.
b. Wear rings and other jewelry when working in the shop.
c. Conduct yourself in a manner conducive to safe shop practices.
d. Do not carry a butane lighter in your pocket when involved in welding activities.

____ 13. Bathing daily and staying in good physical condition are ____ .

a. Things OSHA expects of an employee
b. Good housekeeping rules
c. Rules for personal safety
d. Good physical and hygiene requirements

____ 14. Which shaded lens should be worn when shielded metal arc welding with 1/16" to 5/32" electrodes?

a. 2
b. 3-4
c. 9-14
d. 12-14

____ 15. Safety glasses should be worn _____ .

a. At all times in the welding shop
b. At all times in the classroom and shop
c. Only when grinding
d. Only when chipping slag

____ 16. When in the shop, lens shade numbers are _____ .

a. Additive
b. Not additive
c. Not necessary
d. Not important

____ 17. Which factor does not contribute to back injury?

a. Weight
b. Size
c. Shape
d. Color

____ 18. What is the first step in safely lifting a 25-pound object?

a. Approach the load and estimate its weight and size.
b. Keep feet 4-6 inches apart.
c. Grab it and go.
d. Get a good hand hold on it before lifting.

___ 19. When lifting an object, _____ .

a. Keep knees rigid
b. Keep one knee straight and one knee bent
c. Bend knees
d. Use just one hand

___ 20. Make no turning or twisting motions until the load _____ .

a. Is 6" off the ground
b. Is 8" off the ground
c. Is being moved in an upward motion
d. Is in carrying position

NOTE: Completion of this unit test to the specified score is the student's final evaluation for competency A1: Identify and correct or report safety hazards.

ANSWERS TO UNIT TEST (A1)

1. c
2. ab
3. e
4. bc
5. a
6. d
7. b
8. ad
9. ae
10. ac
11. b
12. b
13. d
14. c
15. a
16. b
17. d
18. a
19. c
20. d

MODULE: BASIC WELDING SKILLS

UNIT III: FIRST AID

UNIT OBJECTIVE

Upon completion of this unit, the student should be able to identify proper first aid skills for typical welding injuries. This knowledge will be evidenced by completing the unit test to specified score.

SPECIFIC OBJECTIVES

After completion of the lessons in this unit, the student should be able to:

1.1 Complete statements concerning general guidelines for first aid emergencies.

1.2 Identify methods of recognizing and treating shock.

1.3 Identify proper first aid treatment for welding injuries such as cuts and burns.

1.4 Select proper treatment for eye injuries that may occur in the shop.

1.5 Identify treatment for controlling bleeding.

2.1 Complete statements concerning electrical safety.

2.2 Solve problems concerning first aid for an electrical shock victim.

MODULE: BASIC WELDING SKILLS

UNIT III: FIRST AID

CONTENTS OF THIS UNIT

A. Objective sheets

B. Notes to the instructor

C. References

D. Lesson plans

1. Lesson 1: WELDING INJURY FIRST AID

    a. Information outline

    b. Handouts

        HO 1.1: Standard student accident form
        HO 1.2: Pressure points

2. Lesson 2: ELECTRICAL SHOCK SAFETY

    a. Information outline

    b. Handout

        HO 2.1: Electrical shock and first aid

E. Unit test

F. Answers to the unit test

REFERENCES

A. Curriculum guide

1. Fortney, Clarence, and Mike Gregory. Introduction to Welding. Stillwater, Okla.: Mid-America Vocational Curriculum Consortium, Inc., 1984.

B. Pamphlet

1. "What everyone should know about electric safety." South Deerfield, Mass.: Channing L Bete Co., Inc., 1985.

NOTES TO THE INSTRUCTOR

A. Suggested approaches to teaching this unit

1. Follow emergency procedures that have been adopted by the local school board and apprise students of these procedures.

2. Invite a Red Cross representative to speak to the class about safety.

3. Contact an area Red Cross chapter for first-aid teaching material such as the Basic Aid Training Kit (BAT). This illustrated kit includes approved first-aid procedures for the class.

4. Explain to students the characteristics of an arc burn and suggested treatment.

MODULE: BASIC WELDING SKILLS

UNIT III: FIRST AID

LESSON 1: WELDING INJURY FIRST AID

I. General guidelines

NOTE: For any injury, always notify the instructor or supervisor as soon as possible. Follow emergency procedures that have been adopted by the local school board.

A. Student responsibilities

1. Reassure the injured person that everything possible is being done. Hearing the concerned voice of a co-worker is psychologically comforting to an injured person and can actually lessen the degree of shock.

2. Report all accidents and injuries to your instructor or job site supervisor, no matter how minor they may seem to be.

B. Instructor duties

1. Always have a reason for any first aid performed.

2. Make accurate notes about the accident including name of victim, time, place, cause or nature of the accident and any first aid that was administered.

3. Notifying the victim's family is the responsibility of the school, the job-site supervisor or the medical facility.

4. File a complete accident report and submit a copy to the proper persons on the same day as the accident (HO 1.1).

II. Shock

A. Recognition

1. Skin is pale or bluish.

2. Skin may be moist and clammy, even cold to the touch.

3. Victim feels weak and may be confused or incoherent.

4. Pulse is rapid and weak; breathing is shallow and the rate is fast and irregular.

5. Dull, lackluster eyes

6. Dilated pupils

B. Treatment

1. Do not delay immediate first aid treatment. It can be life saving.

2. Keep victim lying down. Unless the victim has sustained a head or chest injury, elevate the feet slightly.

3. Cover the victim to retain body heat without making the victim sweat.

4. Withhold liquids or food from the victim.

III First aid for common welding injuries

A. Minor cuts

1. Clean with mild soap and water; rinse thoroughly with water; clean again as required.

2. Cover with dry, sterile dressing.

3. Always consider tetanus as a potential hazard.

B. Puncture wounds, slivers and splinters

1. These through-the-skin wounds need prompt medical attention to avoid infection.

2. Do not attempt to remove deeply imbedded splinters, especially where the area appears infected.

3. Clean with soap and water; rinse thoroughly with water; clean again as required; cover with a dry, sterile dressing.

4. Always consider tetanus as a potential hazard.

C. Thermal (heat) burns

1. Give shock treatment to victim immediately.

2. Remove clothing from area of burn, but do not remove material adhering to burn area.

3. Apply thick, dry, sterile dressing and bandage snugly to exclude air. If sterile dressing is not available, use close-woven, white, clean cloth, and bandage snugly.

D. Chemical burns

1. Immediately wash off chemical with large quantities of running water and give shock treatment.

2. Cut off clothing from affected area.

3. Apply thick, dry, sterile dressing and bandage snugly to exclude air.

4. If sterile dressing is not available, use close-woven, white, clean cloths and bandage.

IV. Eye injury

A. Every eye injury should receive first aid attention.

B. Never permit the victim of an eye injury to rub the eye.

C. For an apparent minor object in the eye, have the person wink several times. If the tears produced by winking do not remove the object, assume that the object is embedded and use the following procedure.

1. Have the victim close his/her eyes.

2. Put a piece of moist, clean cotton over the closed lid.

CAUTION: Never use dry cotton near the eye as it will stick to the eyeball.

3. Place a bandage over both eyes to restrict eye movement, thus lessening eye injury.

4. Get the victim to a medical professional as soon as possible.

D. For chemical or acid splashes, flush the eyes immediately for at least five minutes at an eye-flushing station or use a bottled, portable flushing solution. Seek medical assistance without delay. Use water that is neither hot nor cold.

E. Arc burn characteristics

NOTE: Symptoms do not usually appear until 5-6 hours after the burn.

1. Feeling like sand or dust in the eye

2. Eyes reddish and watery

3. Burning, irritated feeling in eyes

4. Pain when looking at any light source

5. Relief

a. Apply cold compresses.

b. Contact instructor or medical professional as soon as possible.

V. Bleeding

A. Types and characteristics

1. Arterial bleeding: characterized by bright-red blood that spurts from the wound in sometimes alarming quantities

2. Venous bleeding: characterized by dark-red blood that flows from the wound

3. Internal bleeding: characterized by blood being coughed up, vomited or present in the victim's stools

B. Controlling bleeding

1. Use direct pressure at the bleeding site. Press firmly with fingers or palm of one hand.
2. If available, place a compress of sterile gauze or the next cleanest available material directly over the bleeding site.
3. Elevate the bleeding parts above heart level unless there is evidence of a fracture.
4. If blood soaks through the first compress, place another compress on it, but do not remove the first one.
5. Secure compress with a pressure bandage.
6. Treat for shock.

C. Pressure points (HO 1.2)

CAUTION: The pressure point selected must be between the heart and the wound. Instruction by a qualified first aid instructor is the best way to learn where pressure points are and how to be sure the right one is selected.

1. Facial bleeding can often be controlled by pressing the facial artery.
2. Bleeding from the armpit, or sometimes the entire arm, can often be controlled by pressure on the subclavian artery.
3. Bleeding from an arm can often be controlled by pressure on the brachial artery.
4. Bleeding from a leg can often be controlled by firm pressure on the femoral artery.

STANDARD STUDENT ACCIDENT FORM

Part A. Report ALL accidents to Students Occurring Anywhere, Day or Night ☐

1. Name: ______________________ Home Address: ______________________
2. School: ______________________ Sex: M ☐; F ☐. Age: ____ Grade or classification: ____
3. Time accident occurred: Hour ____ A.M.; ____ P.M. Date: ______________________
4. Place of Accident: School Building ☐ School Grounds ☐ To or from School ☐ Home ☐ Elsewhere ☐

5. **NATURE OF INJURY**

- Abrasion ____
- Amputation ____
- Asphyxiation ____
- Bite ____
- Bruise ____
- Burn ____
- Concussion ____
- Cut ____
- Dislocation ____
- Fracture ____
- Laceration ____
- Poisoning ____
- Puncture ____
- Scalds ____
- Scratches ____
- Shock (el.) ____
- Sprain ____
- Other (specify) ______________

PART OF BODY INJURED

- Abdomen ____
- Ankle ____
- Arm ____
- Back ____
- Chest ____
- Ear ____
- Elbow ____
- Eye ____
- Face ____
- Finger ____
- Foot ____
- Hand ____
- Head ____
- Knee ____
- Leg ____
- Mouth ____
- Nose ____
- Scalp ____
- Tooth ____
- Wrist ____
- Other (specify) ______________

DESCRIPTION OF THE ACCIDENT

How did accident happen? What was student doing? Where was student? List specifically unsafe acts and unsafe conditions existing. Specify any tool, machine or equipment involved. ______________________

6. Degree of Injury: Death ☐ Permanent Impairment ☐ Temporary Disability ☐ Nondisabling ☐
7. Total number of days lost from school: ____ (To be filled in when student returns to school)

Part B. Additional Information on School Jurisdiction Accidents

8. Teacher in charge when accident occurred (Enter name): ______________________

Present at scene of accident: No. ____ Yes: ____

9. **IMMEDIATE ACTION TAKEN**

First-aid treatment ____ By (Name): ______________________

Sent to school nurse ____ By (Name): ______________________

Sent home ____ By (Name): ______________________

Sent to physician ____ By (Name): ______________________

Physician's Name: ______________________

Sent to hospital ____ By (Name): ______________________

Name of hospital: ______________________

10. Was a parent or other individual notified? No: __ Yes: __ When: __________ How: __________

Name of individual notified: ______________________

By whom? (Enter name): ______________________

11. Witnesses: 1. Name: ______________ Address: ______________

2. Name: ______________ Address: ______________

12. **LOCATION**

Specify Activity

- Athletic field ____
- Auditorium ____
- Cafeteria ____
- Classroom ____
- Corridor ____
- Dressing room ____
- Gymnasium ____
- Home Econ. ____
- Laboratories ____

Specify Activity

- Locker ____
- Pool ____
- Sch. grounds ____
- ____ shop ____
- Showers ____
- Stairs ____
- Toilets and washrooms ____
- Other (specify) ____

Remarks

What recommendations do you have for preventing other accidents of this type? ______________________

Signed: Principal: ______________________ Teacher: ______________________

(National Safety Council—Form School 1) Rep.

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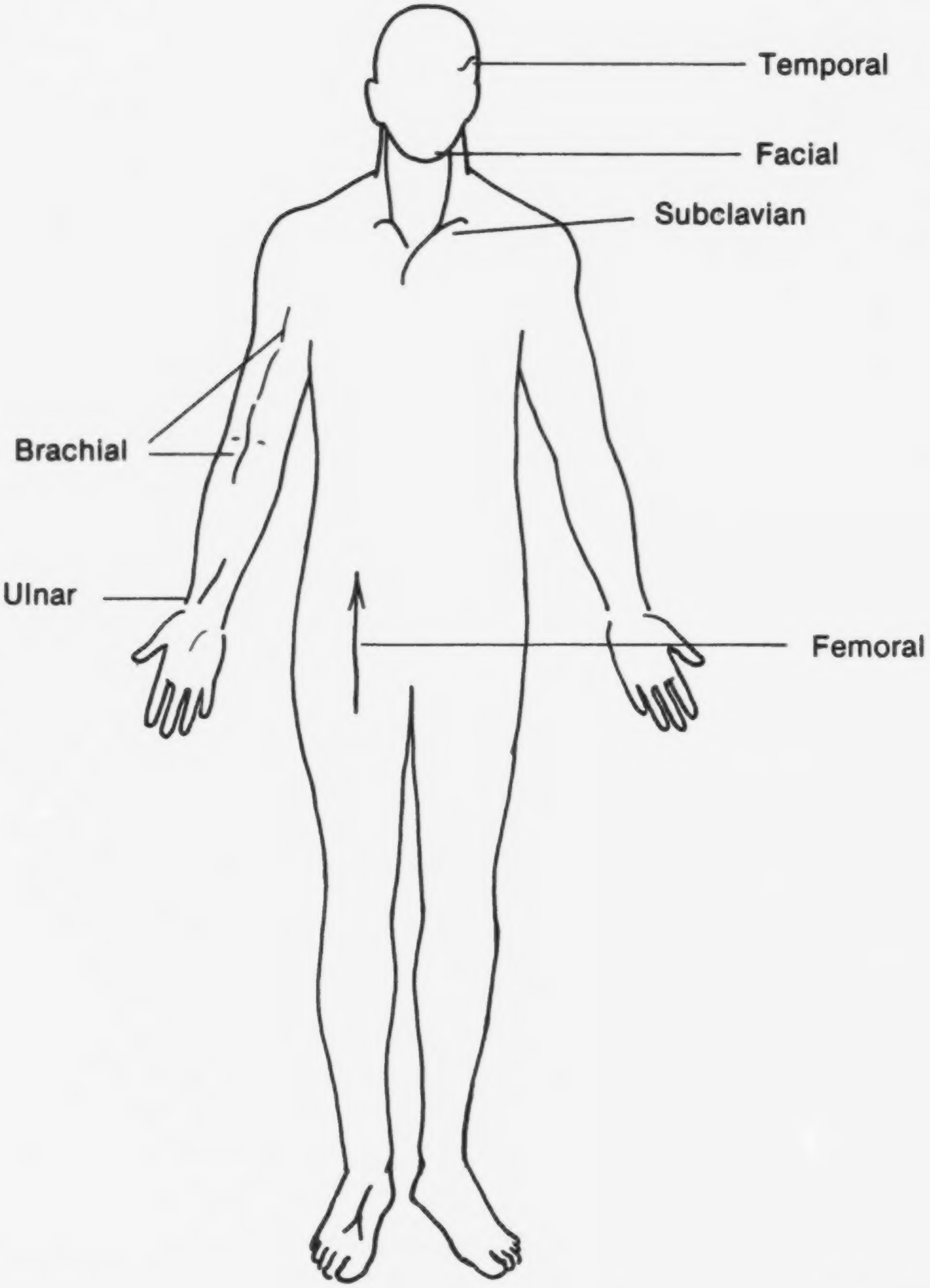
PRESSURE POINTS


Temporal
Facial
Subclavian
Brachial
Ulnar
Femoral

MODULE: BASIC WELDING SKILLS

UNIT III: FIRST AID

LESSON 2: ELECTRICAL SHOCK SAFETY

I. Electrical safety

   A. Electrical equipment should be operated only with supervisor instructions.

   B. Do not touch live electrical parts with bare skin.

   C. Electrical parts should be handled with dry gloves and clothing.

   NOTE: To prevent harmful body shocks, keep hands, feet and clothing dry. Use a dry board or rubber mat when water, moisture or perspiration cannot be avoided.

   D. Operate equipment within its rated capacity.

   E. Know cable loads and use welding cables at currents within their capacity.

   F. Replace worn or bare cables to prevent electrical shock or damage to equipment. Cables can be taped, provided that the tape has an electrical resistance that is equal to the original insulation.

   G. Make sure all cable connections are tight; loose connections could cause overheating of cables and electrical terminals.

   H. When not in use, place an electrode holder where it does not come in contact with a grounded metal surface so the welding machine doesn't become short-circuited.

   I. Machines must be installed according to national and local electrical codes.

   J. Adjustments or repairs should be done only by authorized persons. Make adjustments or repairs to electrical equipment only after all power has been disconnected or the electrical breaker has been turned off.

   K. Know where all emergency shut-down switches are located.

   L. All electrical equipment and tools should be properly grounded to prevent injury to the operator.

II. First aid for a victim of electrical shock (HO 2.1)

   A. Safely remove the victim from the electrical source using the following procedures.

   CAUTION: Do not touch the electrical circuit or the victim unless you are insulated or the power is off.

   1. Turn off electricity at a switch or circuit breaker or cut cables/wires by means of a wood-handled axe or insulated cutters, if available.

2. Use a dry stick, rope, leather belt, coat, blanket or any other nonconductor of electricity to separate the victim from the electrical circuit.

B. Call for assistance

1. Others in the area may be more knowledgeable than you about treating the victim.

2. Another person can call for professional medical help while first aid is being administered by a qualified person.

C. Check victim's breathing and heartbeat. Mouth-to-mouth or cardiopulmonary resuscitation may be needed at this critical point.

CAUTION: Administer first aid only within your ability until medical help arrives.

D. Administer first aid for shock and burns as necessary.

1. Use blankets or coats to help keep the victim warm and comfortable while waiting for help.

2. Raise victim's legs slightly above head level to help prevent shock.

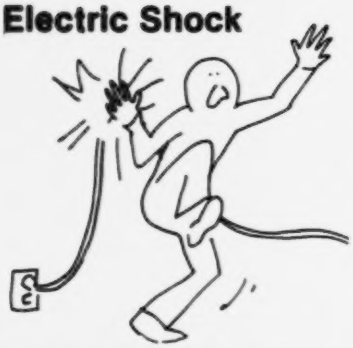
3. If the victim has suffered burns, bandage as follows.

    a. Cover your mouth and nostrils with gauze or a clean handkerchief to prevent germ transmission to the victim while treating the burns.

    b. Wrap burned area firmly with sterile gauze or clean linen or towels.

CAUTION: Do not attempt any other treatment of burns without proper training.

Electric Shock



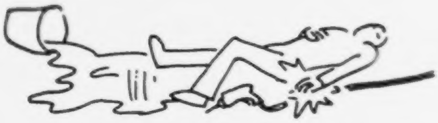
It's the CURRENT (not the voltage) that does most damage. A high voltage causes violent muscular reaction-sometimes enough to throw victim clear of circuit.

Current Effects on the Body

- **Contraction of chest muscles** interferes with breathing. It can cause asphyxiation if prolonged.
- **Paralysis of nerve center** can result in respiratory failure.
- **Upset normal heart rhythm** can cause blood circulation to stop.
- **Hemorrhages and destruction** of tissues, nerves and muscles can result from heat of heavy current.

In an electrical emergency
Give First Aid

First...



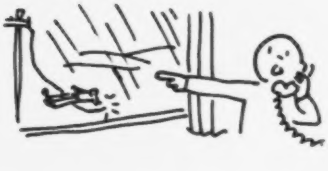
If victim is in contact with live, INDOOR, low voltage electricity:

Shut off power if possible (pull plug, turn off switch).

Otherwise, FREE the VICTIM (use dry rope, stick,etc. Be sure your hands are dry and you're on a dry surface.)

If victim is in contact with live OUTDOOR wire:

Call power company -let THEM turn off power.



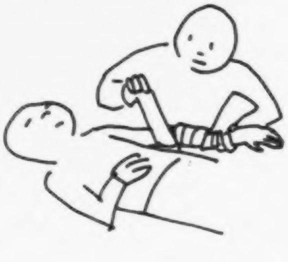
Then-as needed-treat victim for:

Burns

CUT away loose clothing.

COVER burned area with sterile dressing.

TREAT for shock and get medical aid at one.



Shock

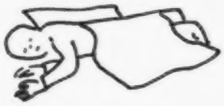
TREAT causes of shock (stopped breathing, blood loss, etc.).

KEEP victim lying down. Place unconscious victim on side to allow drainage of fluids.

DON'T MOVE victim if you suspect neck or spine injury, unless absolutely necessary.

COVER only enough to maintain body heat.

GET medical help immediately.



MODULE: BASIC WELDING SKILLS

UNIT III: FIRST AID

UNIT TEST

The following statements present situations in which first aid is required. Read the statements carefully and select the correct course of action.

____ 1. A classmate has suffered a minor cut while working with a piece of metal. The cut has been rinsed and cleaned with mild soap and water, but it still looks as if dirt might be in it. What should be done next?

a. Nothing--the cut has already been cleaned.
b. Clean the cut again and cover with a dry, sterile dressing.
c. Call a doctor.
d. Apply a strong disinfectant.

____ 2. A classmate complains of a splinter in her wrist. What is the recommended course of action?

a. Notify supervisor.
b. Clean with disinfectant and apply a moist dressing.
c. Rush the victim to an emergency room.
d. Clean and bandage the wound after carefully removing the splinter.

____ 3. A classmate has just had a hard bump on the head. A few moments later he complains of feeling weak. You reach over to help him to a chair and suspect shock. What symptoms are typical of shock?

a. Hot, dry skin
b. Bright, glossy eyes
c. Slow pulse, hot feeling skin
d. Dilated pupils; rapid, weak pulse

____ 4. When should a complete accident report be submitted to the proper persons?

a. The same day as the accident
b. Soon after--usually the next day
c. During the same week
d. Before the end of the semester

____ 5. A classmate has suffered a bad cut. The cut is cleaned and a compress applied, but in a few moments the compress is bloody and messy. What should be done?

a. Remove the blood-soaked compress and apply another.
b. Elevate the bleeding parts above heart level (unless there's evidence of a fracture). Apply pressure and an additional compress.
c. Apply a tourniquet and notify instructor.
d. Treat for shock after removing and replacing compress.

____ 6. A classmate has suffered an eye injury. Nothing appears to be embedded in the eyeball, and the rest of the eye appears free of any foreign matter, but the student complains of great pain. What should be done?

a. Use cold water to flush the eye.
b. Prevent the victim from rubbing the eye; get medical attention promptly.
c. Put a piece of dry cotton over the eye, bandage and get medical attention.
d. Flush with water, bandage with dry cotton and seek medical attention.

____ 7. In the event of an accident, what are good general guidelines to follow?

a. Report any serious accidents or injuries to your supervisor. Minor accidents don't need to be reported.
b. Administer any first aid you can as quickly as you can.
c. Reassure the victim, report the accident and make notes about what happened.
d. Reassure the victim, report the accident and notify the victim's family.

____ 8. What is the proper order of treatment for a chemical burn?

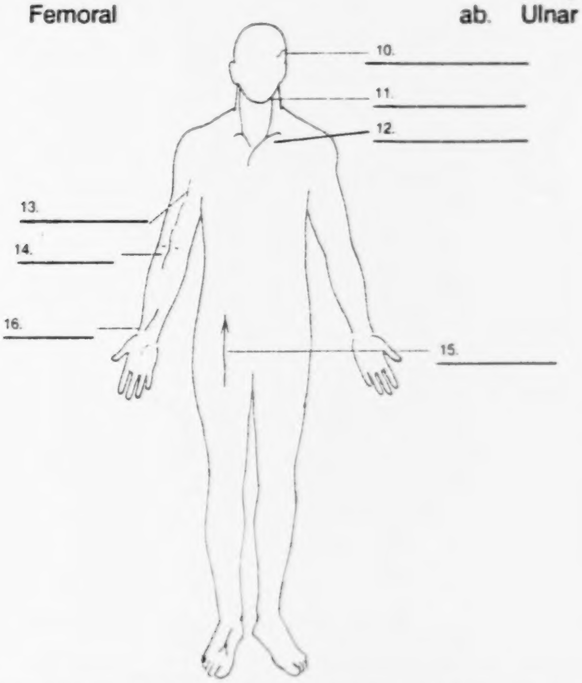
a. Immediately wash off chemical with large quantities of water; give shock treatment.
b. Cut away clothing; give shock treatment; wash with running water.
c. Bandage and give shock treatment.
d. Bandage and seek immediate medical aid.

____ 9. What should be done for a thermal (heat) burn?

a. Remove material adhering to burn and bandage with dry, sterile dressing.
b. Remove material from area of burn and burn area; bandage and give shock treatment.
c. Give immediate shock treatment; apply sterile bandage loosely after removing all clothing from burn.
d. Give immediate shock treatment; apply dry, sterile bandage snugly.

Identify pressure points for checking bleeding by placing the appropriate letter in the corresponding blank. (Answers may be used more than once.)

a. Brachial
b. Facial
c. Femoral
d. Subclavian
e. Temporal
ab. Ulnar



Select the option which best answers the question or completes the statement.

____ 17. Do not operate _______ equipment without supervisor instructions.

a. Any welding
b. Any mechanical
c. Electrical
d. All of the above

____ 18. Electrical equipment should never be operated with _______ .

a. Wet gloves
b. Wet clothing
c. Lightweight cloth or plastic gloves
d. Any of the above

____ 19. You hear a shout and turn to see that a fellow worker has fallen to the floor and is lying on an electrical line. What is the first thing you should do?

a. Turn off electricity at the circuit breaker.
b. Call for help immediately.
c. Check the victim's breathing and heartbeat.
d. Treat for shock.

____ 20. Which is not an electrical safety guideline?

a. Operate equipment within its rated capacity.
b. Know where all emergency shut-down switches are located.
c. Tape worn or bare cables with electrically resistant tape.
d. When not in use, place an electrode holder in contact with a grounded metal surface.

ANSWERS TO UNIT TEST

1. b
2. a
3. d
4. a
5. b
6. b
7. c
8. a
9. d
10. e
11. b
12. d
13. a
14. a
15. c
16. ab
17. d
18. b
19. a
20. d

MODULE: BASIC WELDING SKILLS

UNIT IV: SHOP SAFETY

UNIT OBJECTIVE

Upon completion of this unit, the student should be able to discuss important rules for basic welding safety, relate color-coded safety signs and tags to uses, select extinguishers for given classes of fires and identify correct storage and handling of gases. This knowledge will be evidenced by completing the unit test to specified score.

SPECIFIC OBJECTIVES

After completion of the lessons in this unit, the student should be able to:

1.1 Complete statements concerning the ALWAYS rules for welding safety.

1.2 Complete statements concerning the NEVER rules for welding safety.

1.3 Select true statements concerning shop safety rules.

1.4 Complete statements concerning protective clothing for welding.

2.1 Match safety color codes with uses.

2.2 Match accident prevention signs with colors and uses.

2.3 Match accident prevention tags with colors and uses.

3.1 Identify classes of fires.

3.2 Match types of fire extinguishers with uses.

3.3 Select true statements concerning fire safety rules.

3.4 Define the three components of the fire triangle.

4.1 Complete statements concerning handling and safe storage of gases.

4.2 Complete statements concerning rules for safely handling gas cylinders.

MODULE: BASIC WELDING SKILLS

UNIT IV: SHOP SAFETY

CONTENTS OF THIS UNIT

A. Objective sheets

B. References

C. Notes to the instructor

D. Lesson plans

1. Lesson 1: WELDING SAFETY
   - a. Information outline
   - b. Handout
     - HO 1.1: What's wrong with this picture?
   - c. Assignment sheet
     - AS 1.1: Welding safety
   - d. Answers to assignment sheet
2. Lesson 2: SAFETY SIGNS AND COLORS
   - a. Information outline
   - b. Assignment sheet
     - AS 2.1: Safety color codes
   - c. Answers to assignment sheet
3. Lesson 3: FIRE EXTINGUISHERS
   - a. Information outline
   - b. Handout
     - HO 3.1: Fire safety
4. Lesson 4: GASES
   - a. Information outline
   - b. Assignment sheet
     - AS 4.1: Gases

    c. Answers to assignment sheet

E. Unit test

F. Answers to unit test

REFERENCES

A. Curriculum guide

1. Fortney, Clarence, and Mike Gregory. Introduction to Welding. Stillwater, Okla.: Mid-America Vocational Curriculum Consortium, Inc., 1984.

NOTES TO THE INSTRUCTOR

A. Suggested approaches to teaching this unit

1. HO 1.1 can be used to stimulate student discussion and alertness of hazardous situations, reinforcing rules presented in the information sheets. Some safety hazards students may find are:

    a. Lack of safety glasses and proper clothing

    b. Messy, poorly lit work area

    c. Flammable materials near welding activity

    d. Damp floor

    e. Lack of attention to work; potential horseplay

    f. Inadequate ventilation

    g. Unprotected observer in immediate welding area; observer in contact with welding equipment

    h. Welder's feet tangled in hoses

B. Suggested supplemental materials

1. Welding Supplementary Units. Columbia: Instructional Materials Laboratory, University of Missouri-Columbia, 1988.

2. General Welding Shop Safety (W-76-101). Sedalia, Mo.: The Media Center, State Fair Community College, 1976.

MODULE: BASIC WELDING SKILLS

UNIT IV: SHOP SAFETY

LESSON 1: WELDING SAFETY

I. ALWAYS rules for welding safety

  A. Wear suitable protective clothing and eye protection.

  B. Keep a safe, clean work area.

  C. Keep welding equipment in good condition.

  D. Check welding areas to make sure they're safe places to work.

  E. Respect gas cylinders as dangerous and potentially lethal.

  F. Make sure ventilation provides 3-4 complete changes of air per hour.

II. NEVER rules for welding safety

  A. Never enter the welding shop without wearing safety glasses.

  B. Never weld, cut or grind near flammable or explosive materials.

  C. Never use oil on gas cylinders, regulators, connections or hoses.

  D. Never permit an electrode holder to come in contact with a welding machine or a gas cylinder.

  E. Never operate ungrounded equipment.

  F. Never cut or weld directly on concrete.

  G. Never arc weld or operate electrically powered equipment while standing on wet or damp floors.

  H. Never cut into barrels, drums or any container that has not been purged.

  I. Never ground electrical equipment to a building member or a piece of equipment attached to or part of a building.

  J. Never engage in horseplay of any kind.

III. Shop safety rules

  A. Keep all hand tools sharp, clean and in safe working order.

  B. Report any defective tools, machines or other equipment to the instructor.

  C. Keep all guards and safety devices securely in place.

D. Operate a hazardous machine only after receiving instruction on how to operate the machine safely.

E. Report all accidents to the instructor regardless of nature or severity.

F. Turn off the power before leaving a machine tool.

G. Make sure all guards and barriers are in place and adjusted properly before starting a machine tool.

H. Disconnect the power from machine tools before performing maintenance tasks such as oiling or cleaning.

IV. Protective clothing

A. A welder's cap has a flexible bill and can be slipped around to cover either ear, keeping sparks or metal spatter out of the ear opening.

B. Do not wear clothing made from synthetic materials. Wear heavy, long-sleeved **shirts** with cuffless **pants** that are not frayed at the bottom. Shirt pockets should have flaps.

C. Leather jackets and aprons should be worn for additional protection, especially when welding out of position or in confined areas where flying sparks present an increased hazard.

D. Boots should be made of heavy leather with uppers that reach above the ankle to help prevent burns from sparks and spatter. Although steel-toed boots are not required, they are highly recommended.

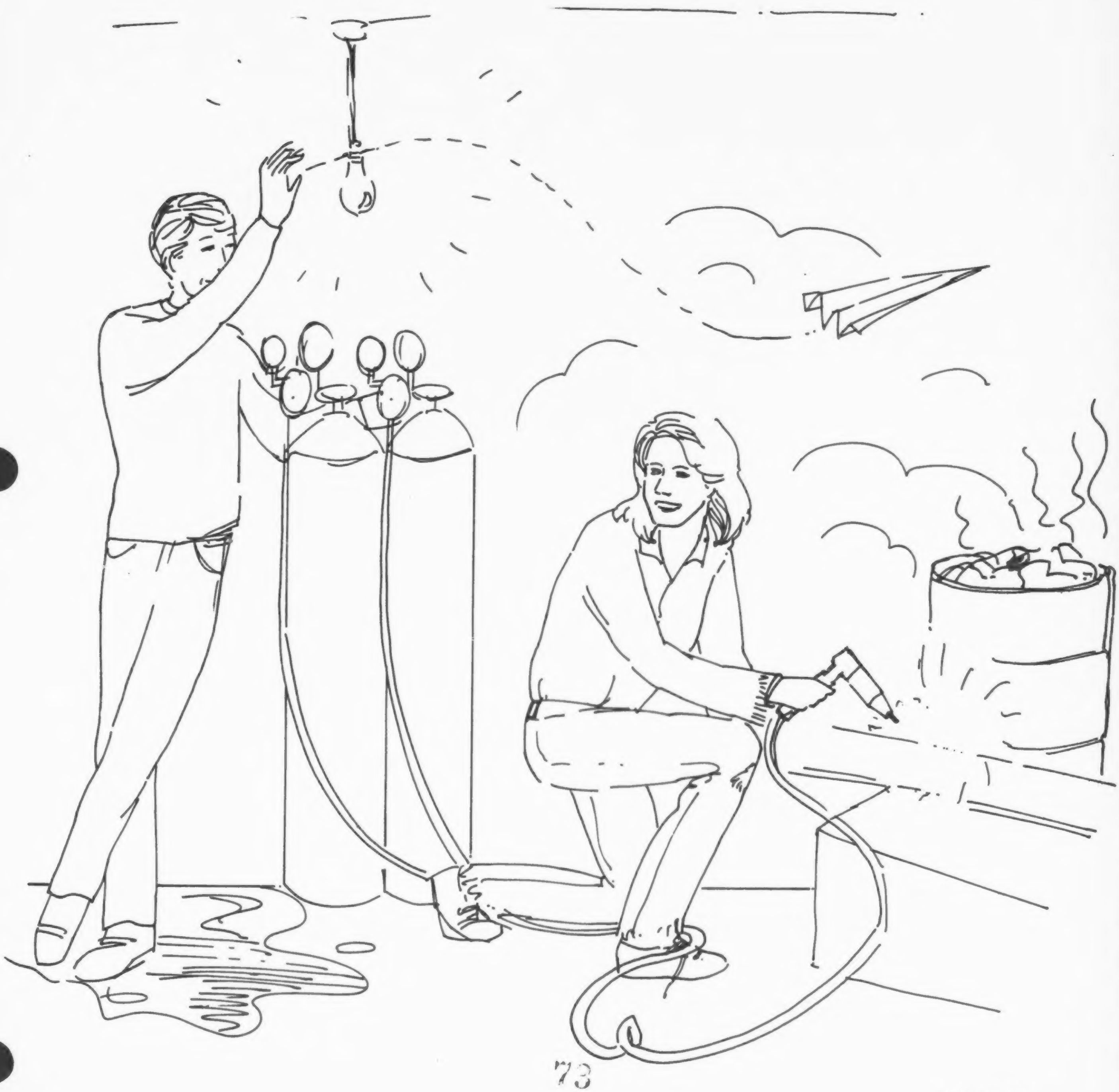
E. Heavy leather gloves with gauntlets are required for all welding and cutting activities.

F. Safety glasses should have nonmetal frames and impact-resistant lenses with side shields to protect from flying objects. Safety glasses should be worn at all times in the shop area.

NOTE: Safety glasses should meet both industry and Occupational Safety and Health Administration (OSHA) specifications.

G. Face shields should be a clear plastic to provide good visibility when chipping or grinding, but still provide protection from particles of slag or metal.

WHAT'S WRONG WITH THIS PICTURE?



WELDING SAFETY

Complete statements concerning rules for welding safety by circling the word(s) that best complete(s) each statement.

1. Always wear suitable protective clothing and (eye protection) (ear plugs) during all activities when in the shop.
2. Always keep a safe, (open) (clean) work area.
3. Always keep welding equipment in (good condition) (an out-of-the-way place).
4. Check welding areas so they're (safe places to work) (not too bright).
5. Always respect gas cylinders as (dangerous and potentially lethal) (expensive and easy to damage).
6. Ventilation must provide (1-2) (3-4) complete changes of air per hour.
7. Never enter the welding shop without wearing (safety glasses) (helmet and gloves).
8. Welding, cutting or grinding should never be done near (other equipment) (flammable or explosive materials).
9. Never use (leak detector) (oil) on gas cylinders, regulators, connections or hoses.
10. Never permit (an electrode holder) (bare hands) to come in contact with a welding machine or a gas cylinder.
11. Equipment that is (obsolete) (ungrounded) should not be operated.
12. Never cut or weld directly (on concrete) (against cast iron).
13. Never arc weld or operate electrically powered equipment while standing (on wet or damp floors) (in a poorly lit area).
14. Barrels, drums or any container that has not been (purged) (opened) should never be cut into.
15. Never (hang) (ground) electrical equipment to a building member or a piece of equipment attached to or part of a building.
16. Never engage in (horseplay of any kind) (unsupervised welding).

Place a T before true statements and an F before false ones.

____ 17. Keep all hand tools sharp, clean and in safe working order.

____ 18. Report any defective tools, machines or other equipment to the instructor.

____ 19. Keep all guards and safety devices securely in place.

____ 20. Operate a hazardous machine only after receiving instruction on how to operate the machine safely.

____ 21. Report only severe accidents to the instructor.

____ 22. Turn off the power before leaving a machine tool.

____ 23. Make sure all guards and barriers are in place and adjusted properly before starting a machine tool.

ANSWERS TO ASSIGNMENT SHEET 1.1

1. Eye protection
2. Clean
3. Good condition
4. Safe places to work
5. Dangerous
6. 3-4
7. Safety glasses
8. Flammable or explosive materials
9. Oil
10. An electrode holder
11. Ungrounded
12. On concrete
13. On wet or damp floors
14. Purged
15. Ground
16. Horseplay of any kind
17. T
18. T
19. T
20. T
21. F
22. T
23. T

MODULE: BASIC WELDING SKILLS

UNIT: SHOP SAFETY

LESSON 2: SAFETY SIGNS AND COLORS

I. Safety color codes and uses

  A. Green

    1. Applied to nonhazardous parts of machine and equipment surfaces such as nameplates and bearing surfaces

    2. Designates safe areas of equipment and also shows location of safety equipment and first-aid materials

  B. Yellow

    1. Applied to operating levers, wheels, handles and hazardous parts that may cause stumbling, falling, snagging or tripping

    2. Designates caution

  C. Orange

    1. Applied to electrical switches, interior surfaces of doors, fuses and electrical power boxes and movable guards and parts

    2. Indicates dangerous parts of equipment that may cut, crush, shock or otherwise physically injure someone

  D. Red--applied to buttons or levers of electrical switches used for stopping machinery and to all pieces of equipment that are fire hazards (such as gasoline cans)

  NOTE: Red is also applied to fire-fighting equipment, such as fire alarms, fire axes and emergency exits.

  E. Blue

    1. Used to identify equipment that is being repaired or is defective and should not be operated

    2. Designates "out of order" or "defective"

  F. Ivory

    1. Applied to label edges, vise jaws and edges of tool rests where extra light reflection is important

    2. No particular designation except to help show tool and equipment moving edges more clearly

G. Black on yellow

  1. Applied to area where radiation is a factor or danger

  2. Designates radiation hazards

H. Black, white and yellow

  1. Applied to floors for safety lanes and locations of housekeeping supplies

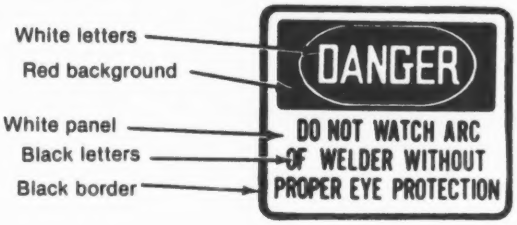
  2. Singly or in combination, these colors are used to identify traffic flow and housekeeping zones

II. Accident prevention signs, colors and uses

A. Danger signs

  1. Used where an immediate hazard exists

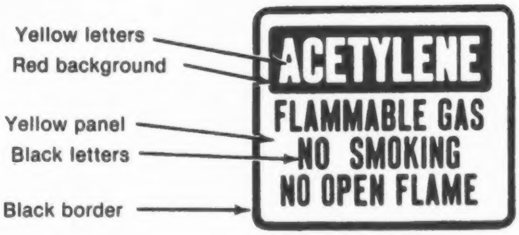
  2. Colors are red, black and white


White letters
Red background
White panel
Black letters
Black border
DANGER
DO NOT WATCH ARC
OF WELDER WITHOUT
PROPER EYE PROTECTION

B. Caution signs

  1. Used to warn against potential hazards or to caution against unsafe practices

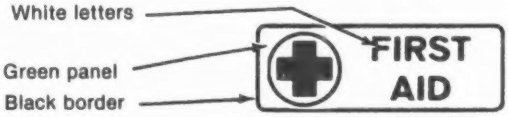
  2. Colors are yellow and black


Yellow letters
Red background
Yellow panel
Black letters
Black border
ACETYLENE
FLAMMABLE GAS
NO SMOKING
NO OPEN FLAME

C. Safety instruction signs

  1. Used where there is a need for general instructions and suggestions relative to safety measures

  2. Colors are white, green and black


White letters
Green panel
Black border
FIRST
AID

III. Accident prevention tags, colors and uses

NOTE: Tags are for temporary use only.

A. "Do not start" tags

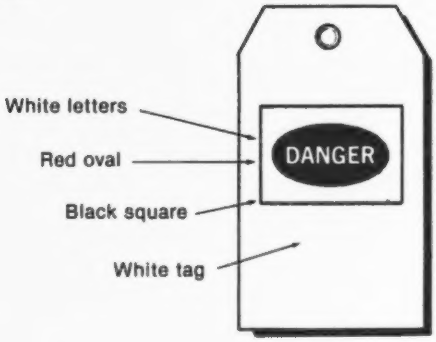
1. Are placed at the starting mechanism on machines that would cause hazardous conditions if the equipment were energized

2. Colors are red, white or gray

B. Danger tags

1. Are placed only where an immediate hazard exists

2. Colors are red, black and white



C. Caution tags

1. Are used to warn against potential hazards or to caution against unsafe practices

2. Colors are yellow and black

D. Out-of-order tags

1. Are used to identify pieces of equipment that are out of order

2. Colors are blue and white

AS 2.1

SAFETY COLOR CODES

Match safety color codes to uses.

____ 1. On nonhazardous parts of machine and equipment surfaces, i.e. nameplates and bearing surfaces

____ 2. Applied to operating levers, wheels, handles and hazardous parts that may cause stumbling, falling, snagging or tripping

____ 3. On electrical switches, interior surfaces of doors, fuses and electrical power boxes and movable guards and parts

____ 4. On buttons or levers of electrical switches used for stopping machinery and all equipment that is a fire hazard (such as gasoline cans)

____ 5. Identifies equipment that is being repaired or is defective and should not be operated

____ 6. On label edges, vise jaws and edges of tool rests for extra light reflection

____ 7. On areas where radiation is a factor or danger

____ 8. Applied to floors for safety lanes and locations of housekeeping supplies

a. Black on yellow

b. Black, white and yellow

c. Blue

d. Green

e. Ivory

ab. Orange

ac. Red

ad. Yellow

Match accident prevention signs and tags with colors and uses.

____ 9. Red, black and white; used where an immediate hazard exists

____ 10. Yellow and black; used to warn against potential hazards

____ 11. White, green and black; used where general safety instructions are needed

____ 12. Red, white or gray; placed at the starting mechanism

____ 13. Red, black and white; placed only where an immediate hazard exists

____ 14. Used to warn against potential hazards; yellow and black colors

____ 15. Blue and white; used to identify pieces of equipment that are not functioning

a. Caution signs

b. Caution tags

c. Danger signs

d. Danger tags

e. "Do not start" tags

ab. Out-of-order tags

ac. Safety instruction signs

INSTRUCTOR'S NOTE: Completion of this assignment sheet to specified score is the student's final evaluation for competency A5: Observe and adhere to safety labels.

ANSWERS TO ASSIGNMENT SHEET 2.1

1. d
2. ad
3. ab
4. ac
5. c
6. e
7. a
8. b
9. c
10. a
11. ac
12. e
13. d
14. b
15. ab

MODULE: BASIC WELDING SKILLS

UNIT IV: SHOP SAFETY

LESSON 3: FIRE EXTINGUISHERS

I. Types and classifications of fires (HO 3.1)

  A. Class A: fires that occur in ordinary combustible materials (wood, rags, paper, or trash)

  B. Class B: fires that occur in flammable liquids (gasoline, oil, grease, paints and thinners)

  C. Class C: fires that occur in electrical and electronic equipment (motors, switchboards, circuit wiring, radios and television sets)

  D. Class D: fires that occur in combustible metals (powdered aluminum and magnesium)

II. Types, uses and operation of fire extinguishers (HO 3.1)

  A. Water types

    1. These extinguishers are used for class A fires only.

    2. Stored pressure models operate by squeezing the handle or turning a valve.

    3. Cartridge-operated extinguishers operate by turning the cylinder upside down and bumping it.

    4. Water pump tanks operate by pumping the handle.

    5. Soda acid models operate by turning cylinder upside down.

  B. Foam type

    1. Use for class A or class B fires

    2. Operate by turning cylinder upside down

  C. Carbon dioxide types (CO_2)

    1. Use for class B or class C fires

    2. Operate by pulling pin and squeezing lever

  D. Dry chemicai (universal) type

    1. Can be used for class B or class C fires

    2. Operate by pulling pin or rupturing cartridge and squeezing lever

NOTE: Fire extinguishers are not effective for class D fires. Instead, smother metal fires with dry sand, dirt, salt or soda ash.

E. Recommended operations for various extinguisher types

1. Foam: Instead of spraying stream into the burning liquid, allow foam to fall lightly on the fire.

2. Carbon dioxide: Direct discharge as close to fire as possible, first at the edge of flames, then gradually forward and upward.

3. Soda acid: Direct stream at base of fire.

4. Pump tank: Place foot on foot pump and direct stream at base of fire.

5. Dry chemical: Direct at the base of the flames; with a class A fire, follow up by directing the dry chemicals at remaining material that is burning.

III. Fire safety rules

A. Immediately report anything that might indicate a potential fire hazard.

(Examples: The sound of wires shorting even though they can't be seen, a light that blinks on and off and the smell of smoke even when a flame is not apparent)

B. Know the location and the proper operation of fire extinguishers and make sure they have been recently checked.

C. Know where the nearest telephone is and make sure the number of the nearest fire department is listed on the phone.

D. Know the procedure for evacuating the building and the location of all fire exits.

E. Smoke only at authorized times and in authorized areas; make sure cigarette butts are completely extinguished and properly discarded.

F. Examine materials and equipment around the workplace to determine what types of fires might occur. Make sure available fire extinguishers are correct for the classes of fires that might occur.

G. Isolate combustible materials in fire-resistant areas.

H. Dispose of rubbish regularly.

I. Conduct fire drills at regular intervals to make sure the alarm can be heard over shop noises and that everyone knows evacuation routes, exits and assembly points.

NOTE: During a fire alarm, students should go to an assembly point predetermined by the instructor. This point should be used to account for all students who have evacuated the building.

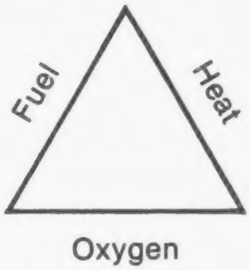
IV. Fire triangle components

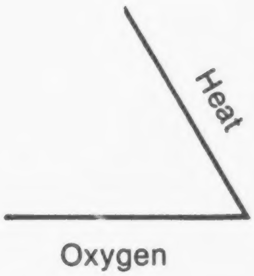
A. Fuel: any combustible material

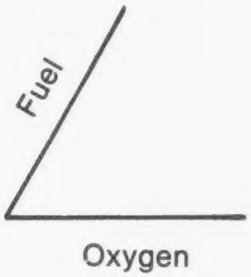
B. Heat: enough to raise the fuel to its ignition temperature

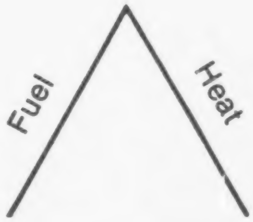
C. Oxygen: necessary to sustain combustion.

NOTE: To produce fire, these three things must be present at the same time. If any one of the three is missing, the fire can be extinguished or will not start.


Fuel
Heat
Oxygen

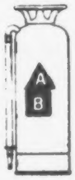
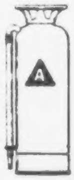
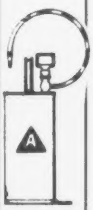
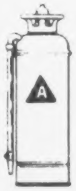
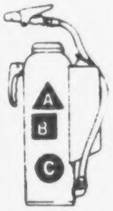
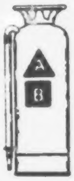
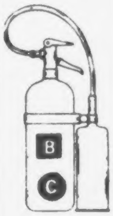
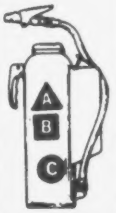
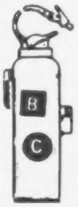
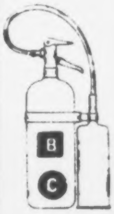
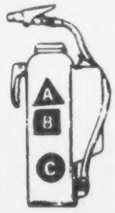
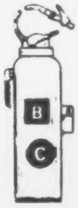

Heat
Oxygen


Fuel
Oxygen



HO 3.1

FIRE SAFETY

Kind of Fire		Approved Type of Extinguisher						
		Mach up proper extinguisher with class of fire shown at left						
DECIDE THE CLASS OF FIRE YOU ARE FIGHTING... ↓	...THEN CHECK THE COLUMNS TO THE RIGHT OF THAT CLASS →	FOAM Solution of Aluminum Sulphate and Bicarbonate of Soda	CARBON DIOXIDE Carbon Dioxide Gas Under Pressure	SODA ACID Bicarbonate of Soda Solution and Sulphuric Acid	PUMP TANK Plain Water	GAS CARTRIDGE Water Expelled by Carbon Dioxide Gas	MULTI-PURPOSE DRY CHEMICAL	ORDINARY DRY CHEMICAL
A 	CLASS A FIRES USE THESE EXTINGUISHERS → Ordinary Combustibles •Wood •Paper •Cloth etc.		X					X
B 	CLASS B FIRES USE THESE EXTINGUISHERS → Flammable Liquids, Grease •Gasoline •Paints •Oils, etc.			X	X	X		
C 	CLASS C FIRES USE THESE EXTINGUISHERS → Electrical Equipment •Motors •Switches etc.	X		X	X	X		

MODULE: BASIC WELDING SKILLS

UNIT IV: SHOP SAFETY

LESSON 4: GASES

I. Handling and safe storage of gases

A. Oxygen

1. Oxygen is a colorless, odorless and tasteless gas.
2. Oxygen supports and can greatly accelerate combustion.
3. Use no oil or grease on oxygen equipment or fittings.
4. Liquid oxygen is extremely cold, so avoid accidental contacts with skin.

   NOTE: Liquid oxygen is 297F below 0.
5. Oxygen should not be stored near acetylene cylinders.

B. Acetylene

1. Colorless gas with a distinctive garlic-like odor
2. Acetylene mixed with oxygen or air in a confined area will explode if brought into contact with a flame or heat source.
3. Should never be used in excess of 15 PSI
4. Store in a well-ventilated area.
5. Acetylene gas, when used in conjunction with oxygen, burns at temperatures up to 6,300F.
6. Acetylene should never be used from a cylinder in a horizontal position because this can separate the acetone from other components and create a dangerous situation.

C. Argon

1. Colorless, tasteless and odorless
2. Nonflammable and inert
3. A shielding gas when during GMAW or GTAW
4. Gives an especially smooth action during welding
5. Should be stored in a well-ventilated area because it will displace oxygen in the air

D. Carbon dioxide

   1. Colorless, tasteless and odorless

   2. A very cold gas that can cause frostbite to the skin

   3. Carbon dioxide can displace the life-giving atmosphere and cause suffocation. Store it in a well-ventilated area.

   4. Used as a shielding gas in a variety of welding operations

E. Nitrogen

   1. Colorless, tasteless and odorless

   2. An extremely cold gas that can cause severe frostbite

F. Helium

   1. Tasteless, colorless, odorless

   2. An inert welding gas used for shielding

   3. Should be stored in a well-ventilated area

G. Propane

   1. Propane, a hydrocarbon, is a colorless gas that is present in petroleum and natural gas.

   2. Should be stored in a well-ventilated area

   3. Propane gas, when used in conjunction with oxygen, burns at temperatures up to 5,190F.

H. Mapp (methylacetylene and propadiene)

   1. Colorless gas with a strong garlic smell

   2. Mapp is an acetylene product that is liquified and stabilized so that it can be used at 375 PSI at 170F.

   3. Should be stored in a well-ventilated area

   4. Mapp gas, when used in conjunction with oxygen, burns at temperatures up to 5,301F.

I. Natural gas

   1. Tasteless, odorless and colorless

   2. A gaseous hydrocarbon that has been distilled

   3. Should be stored in a well-ventilated area

4. When used in conjunction with oxygen, natural gas burns at temperatures up to 5,000F.

II. Rules for handling gas cylinders safely

A. Never use a cylinder cap to lift a cylinder.

B. Never use oil or grease on a cylinder fitting.

C. Never expose a cylinder to excessive heat.

D. Never roll a cylinder horizontally across a floor.

E. Never tamper with or attempt to repair a cylinder valve. Report a damaged valve to the instructor immediately.

F. Keep caps on cylinders when they are not in use.

G. Store all cylinders in well-ventilated areas.

H. Chain all cylinders in an upright position--even empty ones.

I. Do not drop or strike cylinders sharply.

J. Do not use a hammer or wrench to force cylinder valves open.

K. Keep all cylinders away from electrical contact and any welding arc.

L. Close cylinder valves when not in use.

M. Never transport cylinders with regulators attached.

GASES

Complete statements concerning handling and safe storage of gases by inserting the word(s) that best completes each statement.

1. **Oxygen** is a colorless, odorless and _______ gas.
2. Oxygen supports and can greatly accelerate _______.
3. Use no _____ or _____ on oxygen equipment or fittings.
4. Oxygen should not be stored near ______ cylinders.
5. **Acetylene** is a colorless gas with a distinctive _______ odor.
6. Acetylene mixed with oxygen or air in a confined area will _____________ if brought into contact with a flame or heat source.
7. Acetylene should ______ be used in excess of 15 PSI.
8. Acetylene should be stored in a well _______ area.
9. Acetylene should never be used from a cylinder in a _____________ position because this can separate the acetone from other components and create a dangerous situation.
10. **Argon** is a colorless, tasteless and ______ gas.
11. Argon is a ________ gas.
12. Argon gives an especially ______ arc action during welding.
13. Argon should be stored in a well-ventilated area because it will displace _____________ in the air.
14. **Carbon dioxide** is a ________, tasteless and odorless gas.
15. Carbon dioxide can displace life-giving atmosphere, causing ___________. Store in a well-ventilated area.
16. Carbon dioxide is used as a ______ _____ in a variety of welding operations.
17. **Nitrogen** is a colorless, tasteless and _____ gas.
18. **Helium** is a _______, colorless, odorless gas.
19. Helium is an inert welding gas used for ______.
20. Helium should be stored in a well _______ area.
21. Propane gas when used in conjunction with _____________ burns at temperatures up to 5,190F.

22. **Mapp** is a colorless gas that has a strong ______ smell.

23. Mapp is an acetylene product that is ____________ and stabilized so that it can be used at 375 PSI at 170F.

24. Mapp gas, when used in conjunction with _______________ , burns at temperatures up to 5,301F.

25. **Natural gas** is a tasteless, odorless and _______ gas.

26. Natural gas is a gaseous hydrocarbon that has been _____ .

27. Natural gas, when used in conjunction with _____________ , burns at temperatures up to 5,000F.

ANSWERS TO ASSIGNMENT SHEET 4.1

1. Tasteless
2. Combustion
3. Oil, grease
4. Acetylene
5. Garlic-like
6. Explode
7. Never
8. Ventilated
9. Horizontal
10. Odorless
11. Nonflammable or inert
12. Smooth
13. Oxygen
14. Colorless
15. Suffocation
16. Shielding gas
17. Odorless
18. Tasteless
19. Shielding
20. Ventilated
21. Oxygen
22. Garlic
23. Liquified
24. Oxygen
25. Colorless
26. Distilled
27. Oxygen

MODULE: BASIC WELDING SKILLS

UNIT IV: SHOP SAFETY

UNIT TEST

Select the option which best completes the question or statement.

____ 1. Which of the following is hazardous?

- a. Wear suitable protective clothing.
- b. Keep a safe work area.
- c. Play around gas cylinders.
- d. Make sure there is proper ventilation.

____ 2. When working around flammable materials, _____ .

- a. Never weld
- b. Never cut
- c. Never grind
- d. All of the above

____ 3. Which is not a proper safety rule? Weld _____ .

- a. On a steel table
- b. When wearing proper clothing
- c. Directly on concrete
- d. When standing only in dry areas

____ 4. Report defective hand tools and equipment immediately to your ______.

- a. Friend
- b. Parents
- c. School principal
- d. Instructor

____ 5. Guards and safety devices on equipment should be _____ .

- a. Removed and disposed of when they're in the way
- b. Kept securely in place
- c. Bent out of the way
- d. Painted safety green

____ 6. What class of fire occurs in ordinary combustible materials?

- a. A
- b. B
- c. C
- d. D

____ 7. What class of fire occurs in electrical equipment?

a. A
b. B
c. C
d. D

____ 8. Which type of fire extinguisher can be used on a class D fire?

a. Water
b. Carbon dioxide
c. Dry chemical
d. None--extinguishers are not effective on Class D fires.

____ 9. Which type of fire extinguisher would not be used in a welding shop?

a. Foam
b. Water
c. Carbon dioxide
d. Dry chemical

____ 10. To prevent a fire hazard, when beginning a welding operation one should _____ .

a. Have plenty of flammable materials nearby
b. Notify the fire department
c. Examine the area, determine possible fire hazards and have proper fire extinguishers available
d. Have several buckets of water ready in case of a fire

____ 11. Which is not part of the fire triangle?

a. Smoke
b. Heat
c. Oxygen
d. Fuel

____ 12. Which gas is not colorless, odorless and tasteless?

a. Oxygen
b. Carbon dioxide
c. Argon
d. Acetylene

____ 13. Of the following, which is not a fuel gas?

a. Acetylene
b. Propane
c. Mapp
d. Carbon dioxide

____ 14. Cylinders should always _____ .

a. Be treated with extreme care
b. Be stored in properly ventilated areas
c. Be transported with cylinder caps on
d. All of the above

____ 15. Oil and grease should be placed on fittings _____ .

a. Whenever the fittings are very tight
b. Only if you want to promote an explosion
c. Each time a regulator is placed on a cylinder
d. On every other cylinder change-out

____ 16. Which is not cold enough to cause frostbite?

a. Carbon dioxide
b. Nitrogen
c. Liquid oxygen
d. Helium

____ 17. How many complete changes of air per hour should be provided in the welding shop?

a. 1-2
b. 2-3
c. 3-4
d. 4-5

____ 18. Which gas does not need to be stored in a well-ventilated area?

a. Propane
b. Mapp
c. Natural gas
d. Oxygen

____ 19. Which of the following guidelines, if followed, would present a hazardous situation?

a. Never use a cylinder cap to lift a cylinder.
b. Never use oil or grease on a cylinder fitting.
c. A cylinder can be exposed to excessive heat when necessary.
d. Never roll a cylinder horizontally across a floor.
e. None of the above

____ 20. Which guideline would cause a hazard instead of preventing one?

a. Never tamper with or attempt to repair a cylinder valve. Report a damaged valve to your instructor immediately.
b. Keep caps on cylinders when they are not in use.
c. Store all cylinders in well-ventilated areas.
d. Chain all cylinders in an upright position--except for empty ones.

____ 21. Which statement below is not a safety guideline?

a. Do not drop or strike cylinders sharply.
b. Do not use a hammer or wrench to force cylinder valves open.
c. Keep all cylinders away from electrical contact and any welding arc.
d. Close cylinder valves when not in use.
e. None of the above

____ 22. Which of the following does not describe proper SMAW protective clothing?

a. Boots should be made of heavy leather. Steel-toed boots are not recommended because they are too heavy and cause fatigue.
b. A welder's cap has a flexible bill that can be slipped around to cover either ear and keep sparks or metal spatter out of the ear opening.
c. Leather jackets and aprons should be worn for additional protection.
d. Heavy leather gloves with gauntlets are required for all welding and cutting activities.

____ 23. Which of the following does not describe proper SMAW protective clothing?

a. Wear heavy, long-sleeved shirts with pockets that have flaps and cuffless pants that are not frayed at the bottom.
b. Safety glasses should have nonmetal frames and impact-resistant lenses with side shields to protect from flying objects. They should be worn only when preparing metal for welding.
c. Face shields should be a clear-plastic type to provide good visibility when grinding or sanding base metals.
d. Heavy leather gloves with gauntlets are required for all welding and cutting activities.

NOTE: Completion of this unit test to a specified score is the student's final evaluation for competencies A2, A3 and A4.

ANSWERS TO UNIT TEST

1.	c	(A2)
2.	d	(A2)
3.	c	(A6)
4.	d	(A6)
5.	b	(A6)
6.	a	(A3)
7.	c	(A3)
8.	d	(A3)
9.	b	(A3)
10.	c	(A3)
11.	a	(A3)
12.	d	(A2)
13.	d	(A2)
14.	d	(A2)
15.	b	(A6)
16.	d	(A2)
17.	c	(A4)
18.	d	(A2)
19.	c	(A2)
20.	d	(A2)
21.	e	(A2)
22.	a	
23.	b	

MODULE: BASIC WELDING SKILLS

UNIT V: WELDING TOOLS AND EQUIPMENT

UNIT OBJECTIVE

Upon completion of this unit, the student should be able to identify basic hand and power tools used in welding, matching them with characteristics and uses. The student should also be able to list basic rules for the safe use and preventive maintenance of hand and power tools. This knowledge will be evidenced by achieving the specified score on the unit test.

SPECIFIC OBJECTIVES

1.1 Match terms and definitions.

1.2 Match driving and chipping tools with characteristics and uses.

1.3 Select true statements concerning uses of chisels, punches and pry bars.

1.4 Select true statements concerning uses of files and wire brushes.

1.5 Complete rules for basic hand tool use.

1.6 Identify reasons for and methods of properly storing electrodes.

2.1 Match holding, anchoring and alignment tools with characteristics and uses.

2.2 List three types of jacks.

2.3 Match pulling and lifting tools with characteristics and uses.

3.1 Match measuring tools with characteristics and uses.

3.2 Match turning tools with characteristics and uses.

3.3 Match pliers and other manual cutting and shaping tools with uses.

4.1 Match power equipment with characteristics and uses.

4.2 Identify positioning equipment with characteristics and uses.

4.3 Complete statements concerning basic rules for safe use of power tools and equipment

4.4 Identify the No. 1 rule for maintaining a tool or piece of equipment.

MODULE: BASIC WELDING SKILLS

UNIT V: WELDING TOOLS AND EQUIPMENT

CONTENTS OF THIS UNIT

A. Objective sheets

B. References

C. Notes to the instructor

D. Lesson plans

1. Lesson 1: BASIC HAND TOOLS AND EQUIPMENT

    a. Information outline

    b. Transparencies

        TM 1.1: Right and wrong use of tools
        TM 1.2: Right and wrong use of tools (cont.)

    c. Assignment sheet

        AS 1.1: Basic hand tools

    d. Answers to assignment sheet

2. Lesson 2: HOLDING/ANCHORING TOOLS AND JACKS

    a. Information outline

    b. Transparency masters

        TM 2.1: Locking pliers
        TM 2.2: Platen table, tools and accessories
        TM 2.3: Types of jacks
        TM 2.4: Types of jacks (cont.)

    c. Assignment sheet

        AS 2.1: Holding/anchoring tools and jacks

    d. Answers to assignment sheet

3. Lesson 3: MEASURING, TURNING AND CUTTING TOOLS

    a. Information outline

    b. Transparency master

        TM 3.1: Types of calipers

   c. Assignment sheet

      AS 3.1: Measuring, turning and cutting tools

   d. Answers to assignment sheet

4. Lesson 4: POWER EQUIPMENT

   a. Information outline

   b. Assignment sheet

      AS 4.1: Power equipment

   c. Answers to assignment sheet

E. Unit test

F. Answers to unit test

REFERENCES

A. Books

1. Jones, Leonard, and Otto Mores. Sheet Metal Basics. Stillwater, Okla.: Mid-America Vocational Curriculum Consortium, 1983.

2. Madsen, Robert J. Welding Fundamentals. Alsip, Ill.: American Technical Publishers, Inc., 1982.

3. Moses, Napoleon W. Hand Tools for Welding. Mississippi State, Miss.: Research and Curriculum Unit for Vocational-Technical Education, College of Education, Mississippi State University, 1982.

4. Sacks, Raymond J. Welding Principles and Practices. Peoria, Ill.: Charles A. Bennett Co., Inc., 1981.

B. Curriculum guides

1. Fortney, Clarence, and Mike Gregory. Introduction to Welding. Stillwater, Okla.: Mid-America Vocational Curriculum Consortium, Inc., 1984.

2. Fortney, Clarence, and Mike Gregory. Shielded Metal Arc Welding. Stillwater, Okla.: Mid-America Vocational Curriculum Consortium, Inc., 1984.

NOTES TO THE INSTRUCTOR

A. Suggested approaches to teaching this unit

1. Demonstrate the safe and proper use of hand tools as they are presented.

2. Take students on a tour of the welding shop. Demonstrate power tools and equipment. Discuss hazards associated with each piece of equipment and the rules for its safe operation.

3. Invite a manufacturer's representative to give a demonstration of the safe and proper use of selected power equipment.

4. Have trade magazines available for students who are interested in furthering their knowledge of new welding tools and equipment.

5. Arrange a field trip to a local or area welding facility where students can see welding positioners, bending and shaping machines, and other power tools used on the job. Have students discuss the tools and machines and their safe operation.

B. Suggested student activities

1. Have each student select 10 items (such as five tools and five pieces of equipment) to explain to classmates the use and purpose of each item. Students should incorporate safety aspects (right and wrong ways to use the items) in the presentations.

C. Suggested supplemental materials

1. Welding Supplementary Units. Columbia: Instructional Materials Laboratory, University of Missouri-Columbia, 1988.

MODULE: BASIC WELDING SKILLS

UNIT V: WELDING TOOLS AND EQUIPMENT

LESSON 1: BASIC HAND TOOLS

I. Terms and definitions

A. Dies and punches--extremely hard, precisely shaped metal molds used on a press brake for forming angles and shapes in metal

B. Gauge--the measured thickness of metal or wire; an instrument to measure that thickness

C. Hydraulic shear--metal-cutting machine with operating power from fluid transport lines to provide a slower rate of operation than from a mechanical shear

D. Jig--form or frame used to mass-produce a part or to control distortion during a welding process

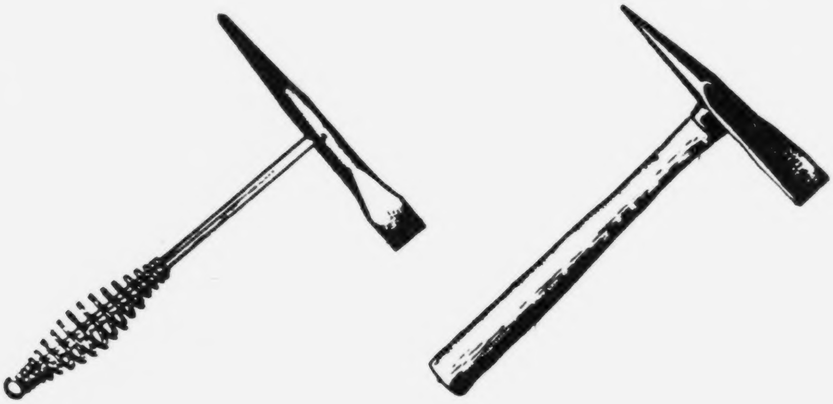
E. Mechanical shear--metal-cutting machine with operating power from a clutch or a flywheel that provides high-speed operation

F. Pneumatic shear--metal-cutting machine with operating power from compressed air in transport lines to provide a slower rate of operating than a mechanical shear

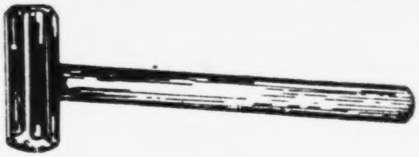
G. Positioners--platforms or bases designed to secure and manipulate welded products so that welding can usually be accomplished from one position to increase welding speed and weld quality

II. Driving and chipping tools, characteristics and uses

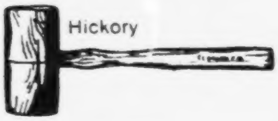
A. Chipping hammer: used to remove slag and residue left on metals after welding or cutting

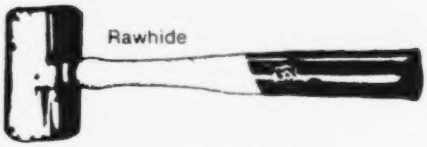


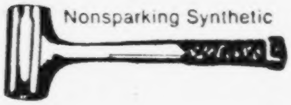
B. Fitter's or engineer's hammer: a heavy hammer with two driving heads used to drive wedges under and between materials; comes in weights of 40, 48 or 64 ounces



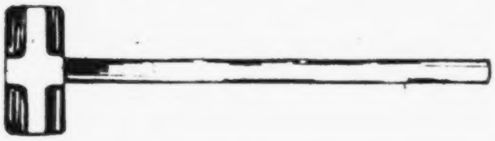
C. Mallets: used where a metal hammer would cause dents or damage; made of hickory, rawhide, lead, nylon, rubber or composition materials



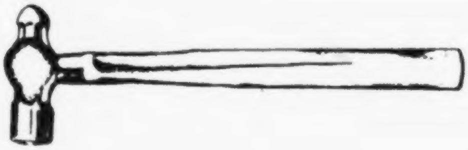




D. Sledge hammer: a long-handled hammer used when more driving force is needed than a smaller hammer can deliver; comes in weights of 2-20 pounds; designed to be used with both hands

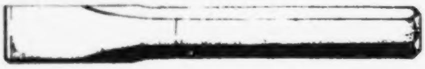


E. Ball-peen hammer: general-purpose with a curved face and rounded head; comes in weights of 4-48 ounces; usually used with one hand

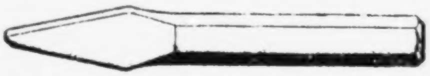


III. Uses of chisels, punches and pry bars

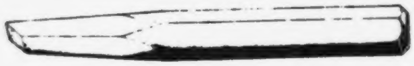
A. Cold chisel: used for cutting metal, rivets, nuts and bolts



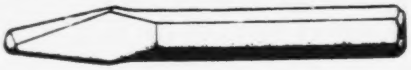
B. Cape chisel: used for cutting keyways in metal



C. Diamond-point chisel: used for cutting V-grooves and cleaning out inside corners



D. Round-nose chisel: used for cutting U-shaped grooves in metal

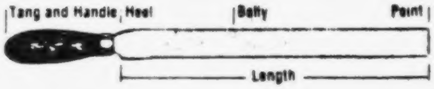


E. Drift punch: used for driving out straight or tapered pins

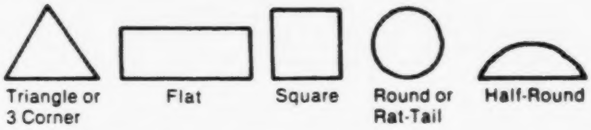
F. Aligning pry bar: used for prying, positioning and aligning parts in fit-up

IV. Files and wire brushes

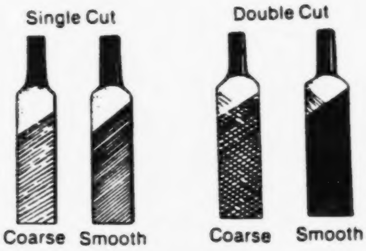
A. Files are used manually to remove metal stock.


Tang and Handle
Heel
Belly
Point
Length

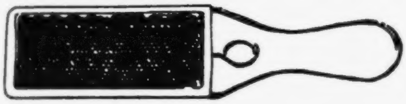
1. Basic shapes of files: triangular, flat, square, round or rat-tail, and half-round to provide a shape to match the job's need


Triangle or 3 Corner
Flat
Square
Round or Rat-Tail
Half-Round

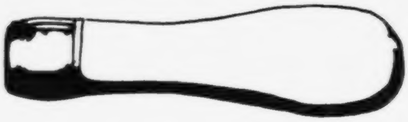
2. Basic file cuts: from single-cut coarse to double-cut smooth to provide textures that produce specific finishes


Single Cut
Double Cut
Coarse
Smooth
Coarse
Smooth

3. Card file: used to clean file



4. File handle: used to cover the tang of a file and protect against injury (A file must not be used without a handle.)

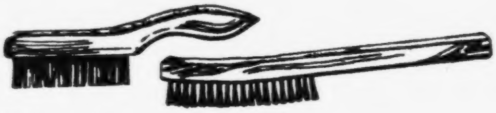


B. Wire brush types and uses

1. Uses: cleaning a weld area before or after welding

2. Types: steel-wire bristles or stainless steel bristles with shoe handles or bent handles

NOTE: Steel-wire brushes should only be used on steel.



V. Basic rules for safe use of hand tools (TM 1.1, 1.2)

A. Do not use a screwdriver as a prying tool.

B. Do not use pliers to loosen or tighten nuts and bolts.

C. Do not use any tool with a loose handle or defective part.

D. When using a screwdriver, support the work on a bench or against a solid surface.

E. When using a wrench, pull it toward yourself to prevent smashing your hand if the wrench should slip.

F. Never use a file without a handle.

G. Secure small parts or objects before working on them with hand tools.

H. Never strike the mushroomed head of a punch or chisel.

VI. Electrode storage

A. Reasons for controlled storage

1. Moisture can change the chemical composition of some flux-covered electrodes.

2. For quality welds, an electrode must be dry. Moist electrodes can cause a weld to be rejected or to fail.

3. Mineral-covered and flux-covered electrodes absorb moisture especially badly soon after unpacking.

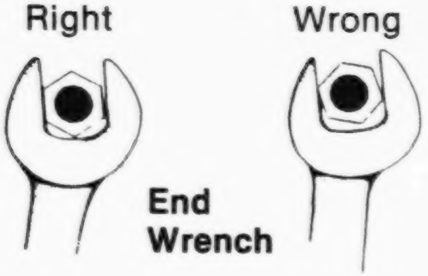
B. Methods of storing electrodes

   1. Electrodes are packaged by the manufacturer in bundles, boxes, coils, reels or spools to prevent moisture damage.
   2. Electrodes not protected by packaging may have to be dried before use.

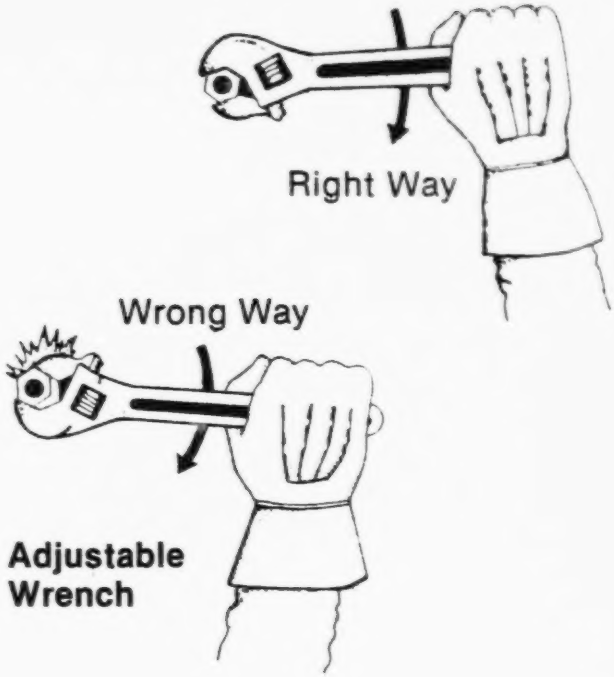
C. Drying damp electrodes

   1. Reconditioning or rebaking times should be as recommended by the drying oven manufacturer in relation to electrode type and relative storage area humidity.
   2. Electrode ovens include electric dry-rod, electrically heated and portable flux-holding.

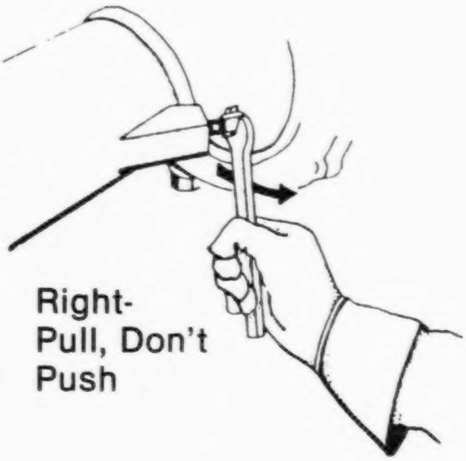
RIGHT AND WRONG USE OF TOOLS


Right
Wrong

End Wrench

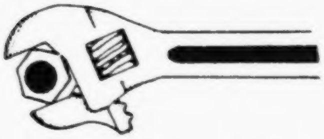

Right Way
Wrong Way

Adjustable Wrench

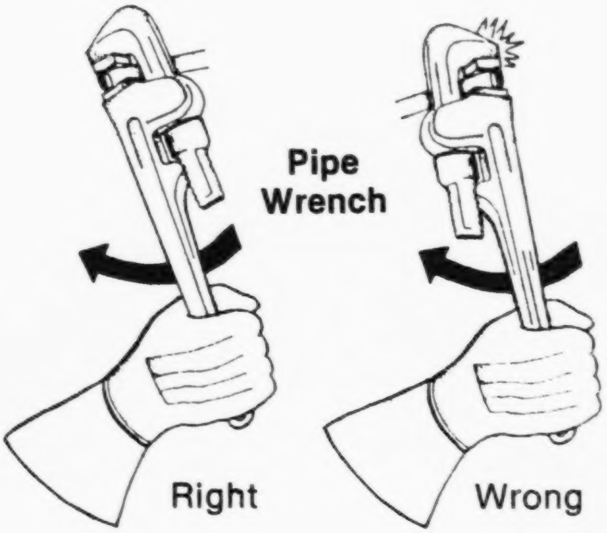


Right-
Pull, Don't
Push

End Wrench-Adjustable Wrench

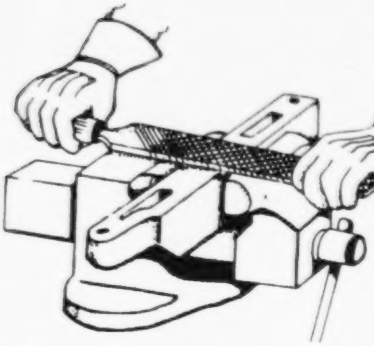


Wrong-Don't Pull on an Adjustable Wrench Until It has Been Tightened on the Nut

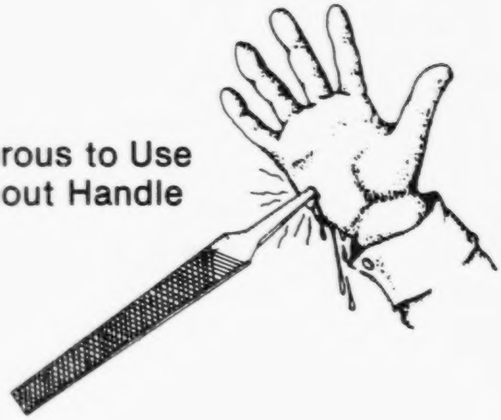

Right
Wrong

Pipe Wrench

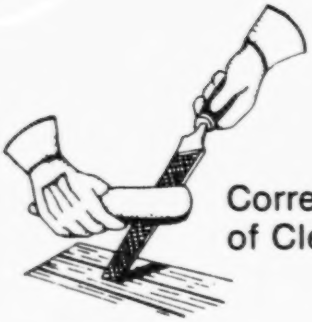
RIGHT AND WRONG USE OF TOOLS (CONT.)



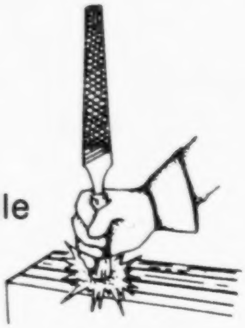
Correct Method of Draw-Filing



It is Dangerous to Use a File Without Handle

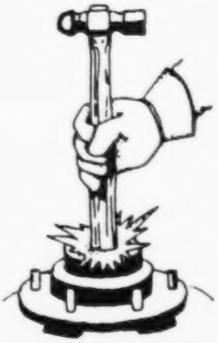


Correct Method of Cleaning a File

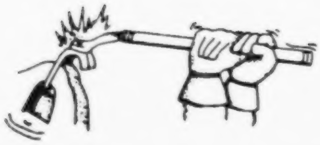


Correct Method of Tightening File Handle

This is Bad Practice



Incorrect Use of a Hammer



Wrong-Never Use a Bar or a Pipe on a Wrench

AS 1.1

BASIC HAND TOOLS

Match tools with characteristics and uses.

____ 1. Used to remove slag and residue left on metals after welding or cutting

____ 2. A heavy hammer with two driving heads used to drive wedges under and between materials

____ 3. Used where a metal hammer would dent or damage material; made of hickory, rawhide, lead, nylon, rubber or composition materials

____ 4. A long-handled hammer used when more driving force is needed than a smaller hammer can deliver; designed to be used with both hands

____ 5. A general-purpose hammer with a curved face and a rounded head; usually used with one hand

____ 6. Used for cutting metal, rivets, nuts and bolts

____ 7. Used for cutting keyways in metal

____ 8. Used for cutting V-grooves and cleaning out inside corners

____ 9. Used for cutting U-shaped grooves in metal

____ 10. Used for driving out straight or tapered pins

____ 11. Used for prying, positioning and aligning parts in fit-up

a. Aligning pry bar

b. Ball-peen hammer

c. Cape chisel

d. Chipping hammer

e. Cold chisel

ab. Drift punch

ac. Diamond-point chisel

ad. Fitter's or engineer's hammer

ae. Mallet

bc. Round-nose chisel

bd. Sledge hammer

Mark a T before true statements and an F before false ones.

____ 12. Files are used manually to remove metal stock.

____ 13. The basic shapes of files are triangular, flat, square, round or rat-tail, and half-round.

____ 14. Basic file cuts, from single-cut coarse to double-cut smooth, provide textures that produce specific finishes.

____ 15. A card file is used to sharpen files.

____ 16. File handles cover the tang of a file and protect against injury.

____ 17. Wire brushes are used only for cleaning a weld area after welding.

____ 18. Wire brushes have steel wire bristles or stainless steel bristles.

Complete statements concerning basic rules for safe use of hand tools by inserting the word(s) that best completes each statement.

19. A screwdriver should never be used as a ______ tool.

20. Do not use pliers to _______ or _______ nuts and bolts.

21. Any tool with a loose _______ or defective part should not be used.

22. When using a screwdriver, support the work against a _______________ surface or on a bench.

23. When using a wrench, pull it _______________ you to prevent smashing your hand if the wrench should slip.

24. Never use a file without a ________.

25. Small parts or objects should be _____ before working on them with hand tools.

INSTRUCTOR'S NOTE: Completion of this assignment sheet to a specified score partially fulfills the student's evaluation for competency A6, A9 and A10.

ANSWERS TO ASSIGNMENT SHEET 1.1

1. d
2. ad
3. ae
4. bd
5. b
6. e
7. c
8. ac
9. bc
10. ab
11. a
12. T
13. T
14. T
15. F
16. T
17. F
18. T
19. Prying
20. Loosen, tighten
21. Handle
22. Solid
23. Toward
24. Handle
25. Secured

MODULE: BASIC WELDING SKILLS

UNIT V: WELDING TOOLS AND EQUIPMENT

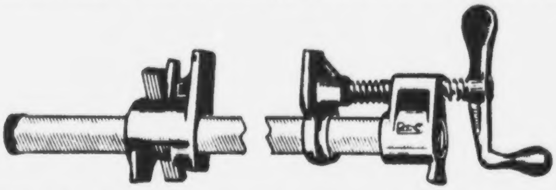
LESSON 2: HOLDING/ANCHORING TOOLS AND JACKS

I. Characteristics and uses of holding and anchoring tools

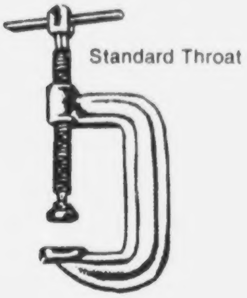
A. Locking pliers: devices used to hold materials until they can be tacked in place; adjustable to almost any metal gauge and handy to work with because they release quickly (TM 2.1)

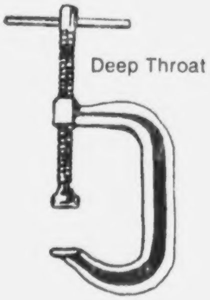
1. Curved jaw
2. Straight jaw
3. C-clamp
4. Long-reach C-clamp
5. Welding clamp
6. Sheet metal
7. Chain clamp

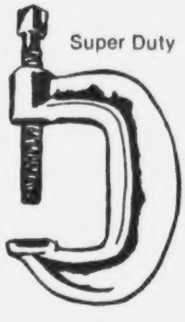
B. Bar clamps: adjustable vice-like devices used to hold materials together until they can be joined by other means; will hold longer and wider materials than a vice



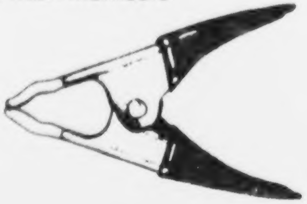
C. C-clamps: used to hold two or more pieces of material together until they can be tacked or joined together by other means



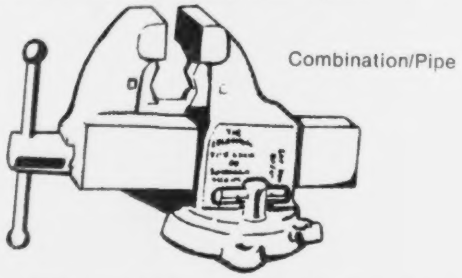




D. Spring clamps: used to secure a tape line to the end of a piece of material or to secure light detail material onto main members



E. Vises: used to secure workpieces that cannot or should not be held by hand; usually fastened to a workbench and have opposing, adjustable jaws



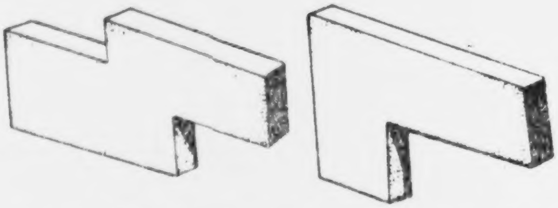
F. Platen table: used to eliminate welding and bending jigs; has special accessories used in layout and other welding activities (TM 2.2)

II. Uses of alignment tools and jacks

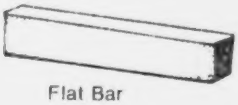
A. Alignment tools

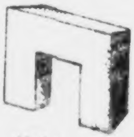
1. Wedges: used to fit-up two or more pieces of material by inserting a V-shaped end between pieces and striking the head or opposite end with a hammer to obtain vertical or horizontal alignment

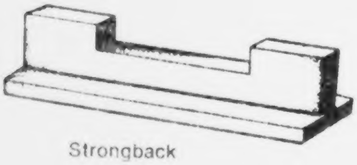
2. Clip plates or dogs: used as a restraining device so that wedges can be applied and driven



3 Flat bar, yoke and strongback: used as restraining devices so that wedges can be applied and driven in situations where clip plates or dogs would not provide enough strength


Flat Bar


Yoke


Strongback

B. Jacks

1. Used for exerting pressure and lifting or lowering heavy objects short distances

2. Types of jacks (TM 2.3, 2.4)

a. Ratchet level jack (railroad jack)

b. Journal jack (bottle jack or booby jack)

c. Hydraulic jack with external pump

d. Push-pull jack (steamboat jack)

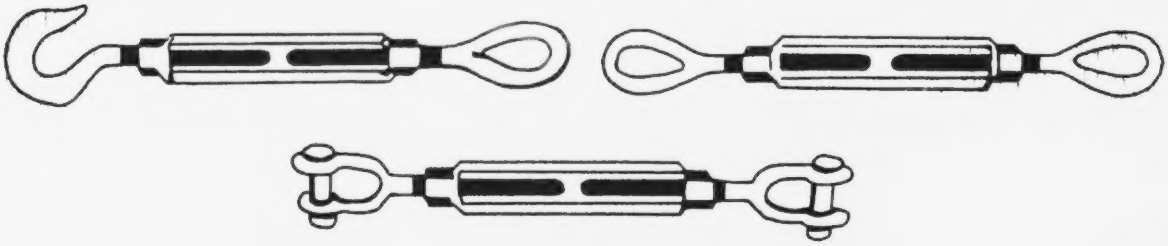
e. Self-contained hydraulic jack

f. Wedge jack

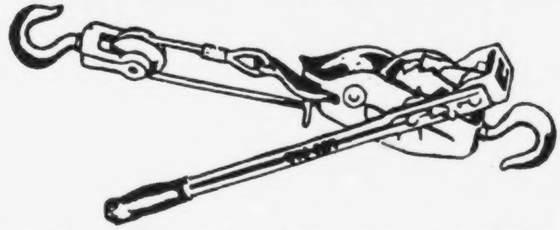
g. Screw jack

III. Characteristics and uses of pulling and lifting tools

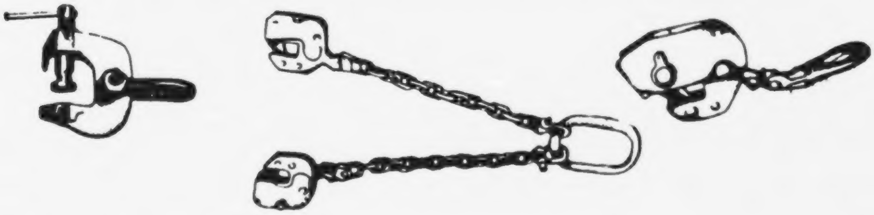
A. Turnbuckles: used to adjust lengths of wire rope or steel rod; adjustable for taking up slack or reducing a load



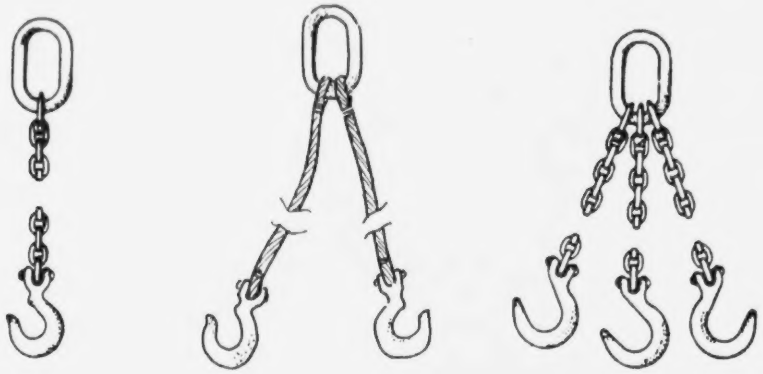
B. Come-alongs: used as manually operated hoists; portable, easy to set-up and constructed of chain or cable



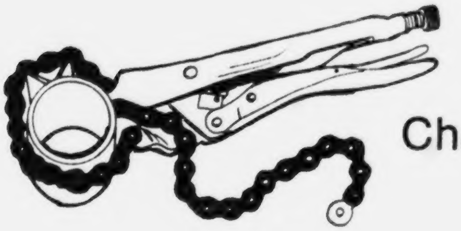
C. Plate dogs: used to lift plates safely and move them from one place to another



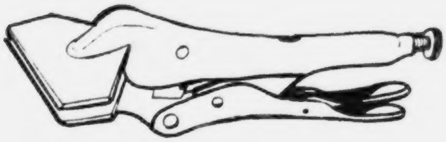
D. **Slings:** cables and hooks or chains and hooks used in single, double, triple or quadruple arrangement for lifting and moving heavy objects



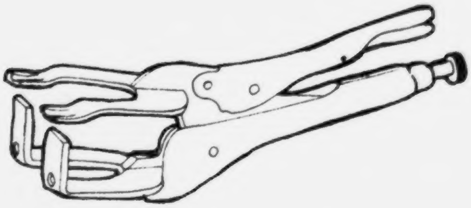
LOCKING PLIERS



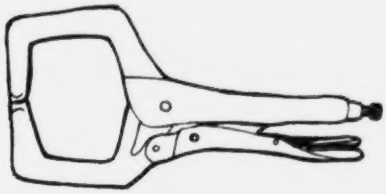
Chain Clamp



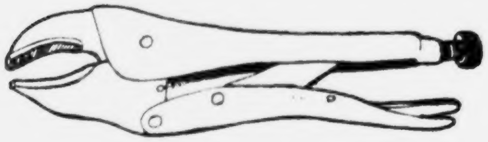
Sheet Metal Tool



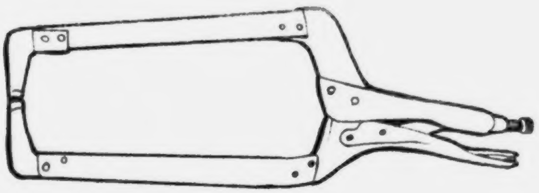
Welding Clamp



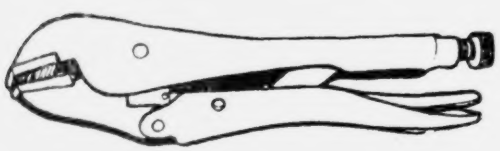
"C" Clamp



Curved Jaw



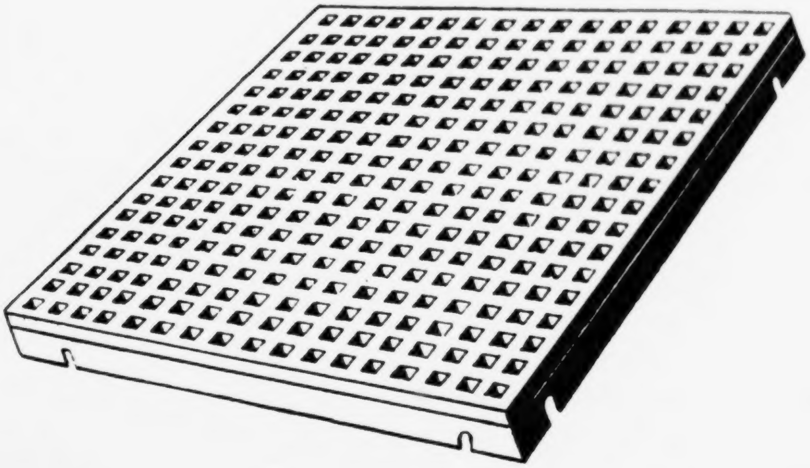
Long-Reach
"C" Clamp

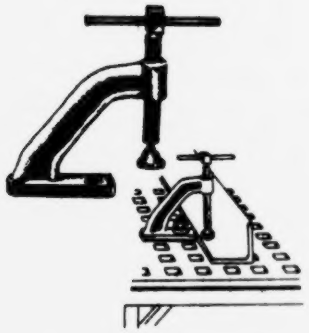


Straight Jaw

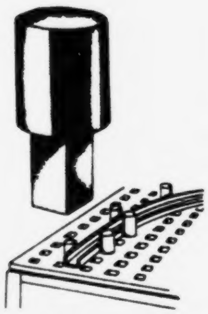
TM 2.2

PLATEN TABLE, TOOLS AND ACCESSORIES

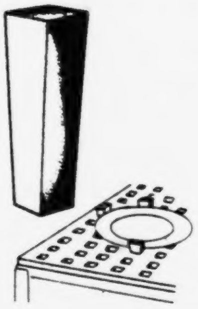




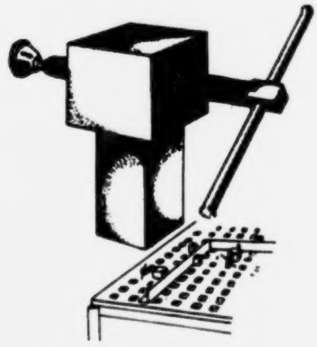
Arm Clamp



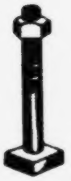
Bending Post



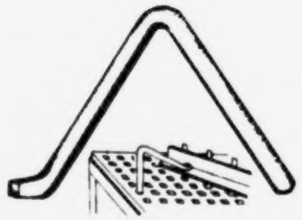
Tapered Drift Pin



Horizontal Clamp

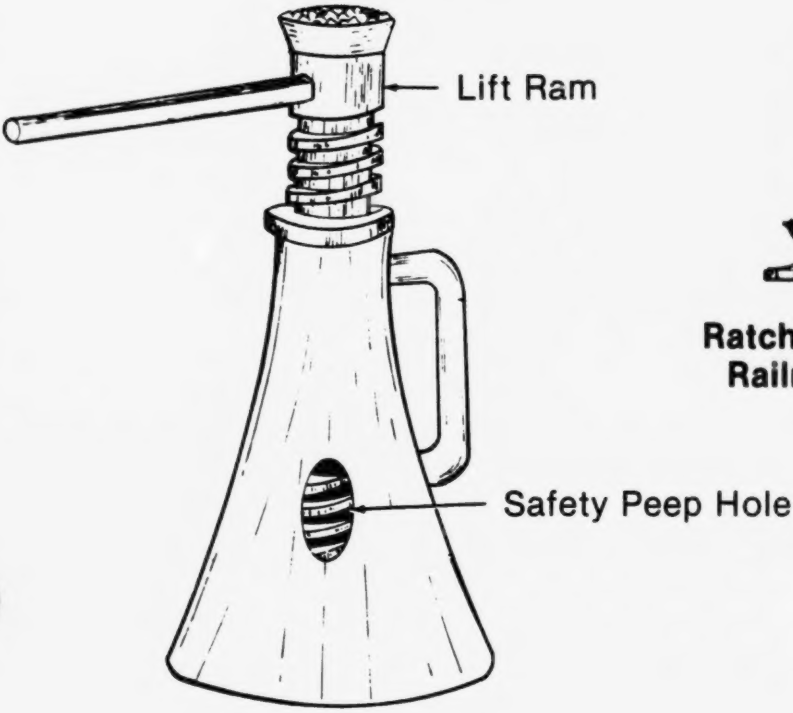


Special
Hold-Down
Bolt & Nut

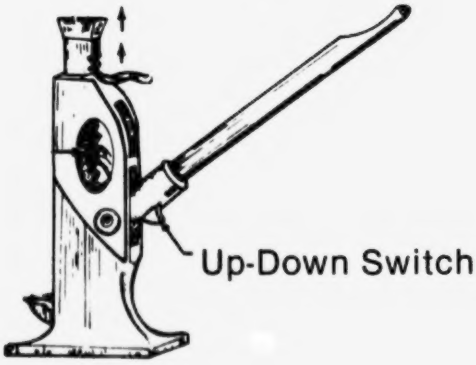


Gooseneck
Hold-Down Dog

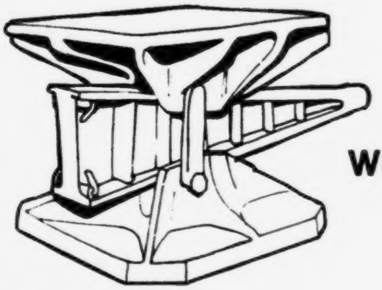
TYPES OF JACKS


Lift Ram
Safety Peep Hole

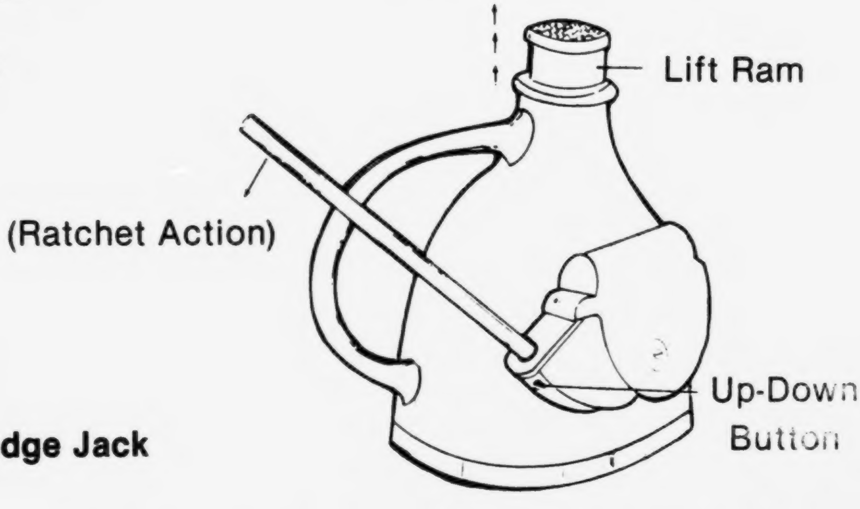
Screw Jack


Up-Down Switch

Ratchet Lever or Railroad Jack



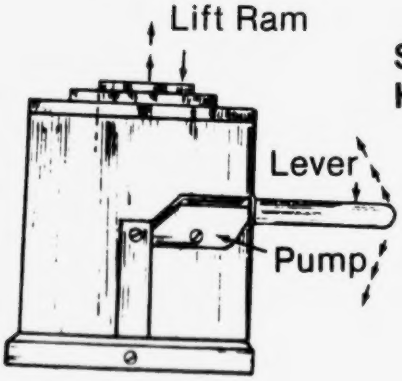
Wedge Jack


Lift Ram
(Ratchet Action)
Up-Down Button

Journal or Bottle Jack

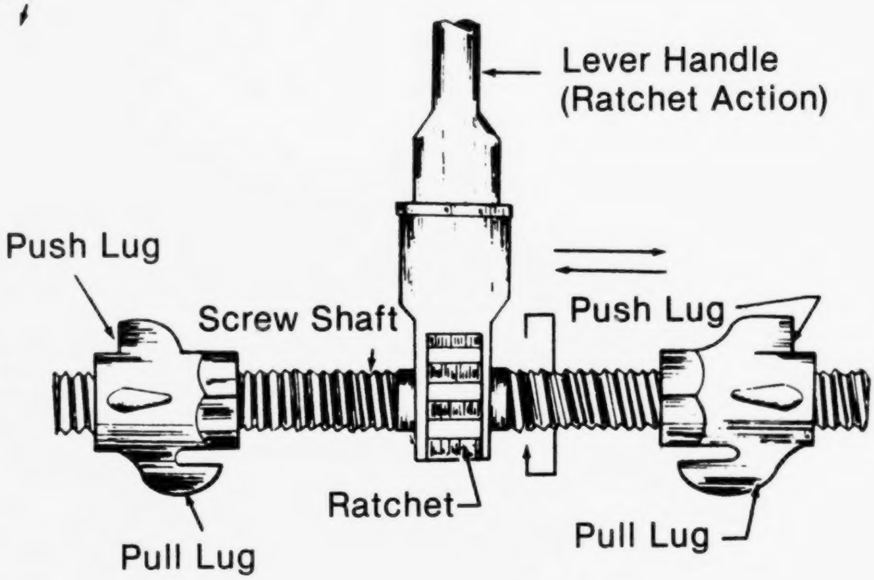
Courtesy Research and Curriculum Unit for Vocational-Technical Education, College of Education, Mississippi State University.

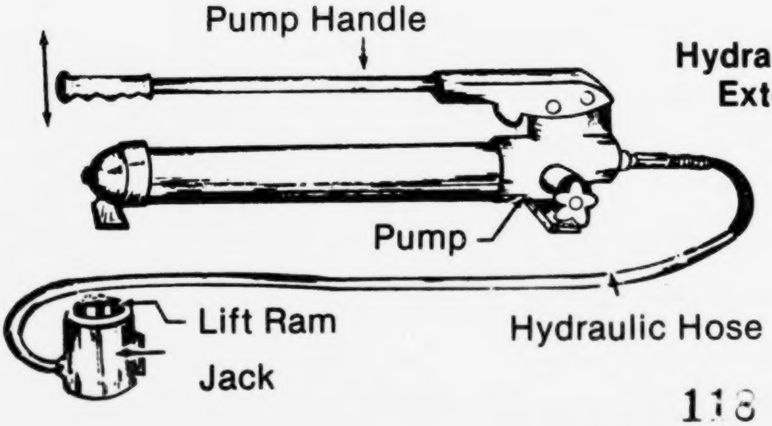
TYPES OF JACKS (CONT.)


Lift Ram
Lever
Pump

Self-Contained Hydraulic Jack

Push-Pull or Steamboat Jack


Lever Handle (Ratchet Action)
Push Lug
Screw Shaft
Push Lug
Ratchet
Pull Lug
Pull Lug


Pump Handle
Pump
Lift Ram
Jack
Hydraulic Hose

Hydraulic Jack with External Pump

AS 2.1

HOLDING/ANCHORING TOOLS AND JACKS

Match tools with characteristics and uses.

____ 1. Plier-type devices used to hold materials until they can be tacked in place

____ 2. Adjustable vice-like devices used to hold materials together until they can be joined by other means; hold longer and wider materials than a vice

____ 3. Hold two or more pieces of material together until they can be tacked or joined together by other means

____ 4. Secure a tape line to the end of a piece of material or to secure light detail material onto main members

____ 5. Secure workpieces that cannot or should not be held by hand; usually fastened to a workbench; adjustable opposing jaws

____ 6. Eliminate welding and bending jigs and has special accessories

____ 7. Used to fit-up two or more pieces of material by inserting a V-shaped end between pieces and striking the head or opposite end

____ 8. Restraining device so that wedges can be applied and driven

____ 9. Restraining devices so that wedges can be applied and driven in situations where clip plates or dogs do not provide enough strength

____ 10. Adjust lengths of wire rope or steel rod; are adjustable for taking up or relieving slack

____ 11. Manually operated hoists; portable; easy to set up; constructed with chain or cable

____ 12. Lift plates safely and move them from one place to another

____ 13. Cables and hooks or chains used in single, double, triple or quadruple arrangement for lifting and moving heavy objects

a. Bar clamps
b. C-clamps
c. Clip plates or dogs
d. Come-alongs
e. Flat bar, yoke and strongback
ab. Plate dogs
ac. Platen table
ad. Slings
ae. Spring clamps
bc. Turnbuckles
bd. Locking pliers
be. Vises
cd. Wedges

List three types of jacks.

14. ____

15. ____

16. ____

INSTRUCTOR'S NOTE: Completion of this assignment sheet to a specified score partially fulfills the student's evaluation for competency A6, A9 and A10.

ANSWERS TO ASSIGNMENT SHEET 2.1

1. bd
2. a
3. b
4. ae
5. be
6. ac
7. cd
8. c
9. e
10. bc
11. d
12. ab
13. ad

14-16. Any three of the following:
Ratchet level (railroad)
Journal (bottle or booby)
Hydraulic with external pump
Push-pull (steamboat)
Self-contained hydraulic
Wedge
Screw

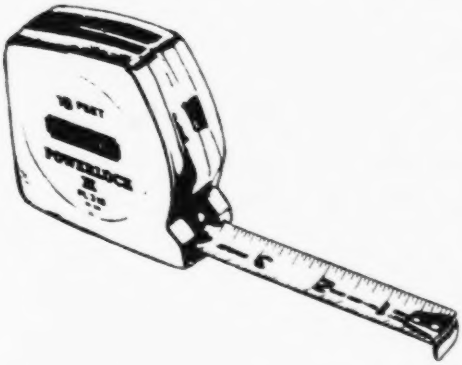
MODULE: BASIC WELDING SKILLS

UNIT V: WELDING TOOLS AND EQUIPMENT

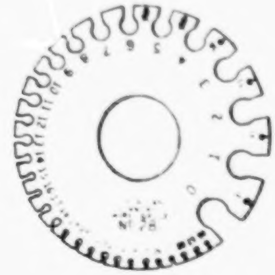
LESSON 3: MEASURING, TURNING AND CUTTING TOOLS

I. Characteristics and uses of measuring tools

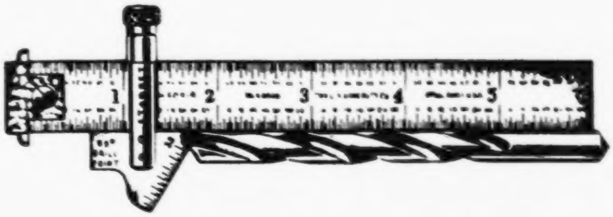
A. Pocket tape: used to measure gauges, set lines, holes, work points and many other straight line measurements up to 25'; often used by fitters; made to be carried on a welder's belt



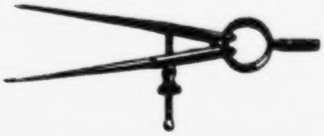
B. American and U.S. standard metal gauges: used to measure the thickness of sheet metal, plate and wire



C. Drill point gauge: used to assure that drill tips being sharpened are kept centered at an angle of 59 degrees so that they will cut faster with less applied force



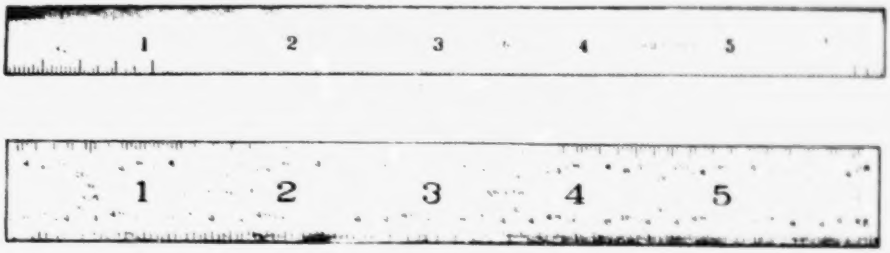
D. Wing dividers: used to construct small circles and arcs and transfer measurements



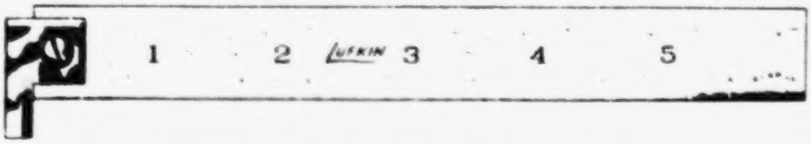
E. Calipers: used for inside and outside measurements. Types: inside, outside, hermaphrodite, slide caliper, dial caliper (TM 3.1)

F. Rules: measuring devices graduated in whole units and fractions; used in measuring distances up to 48 inches

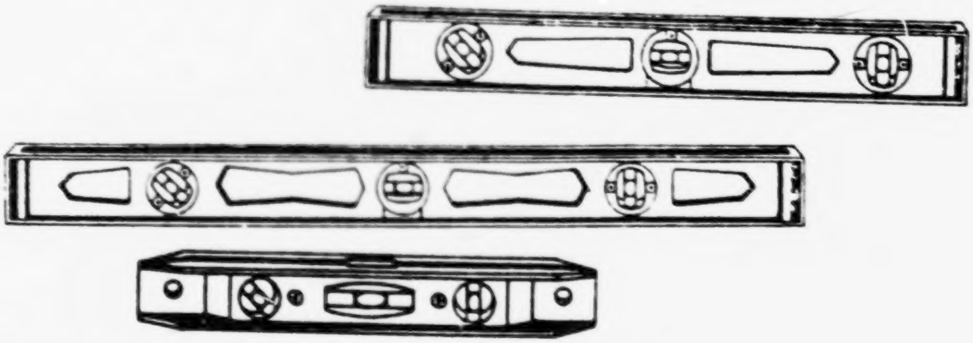
Steel rule



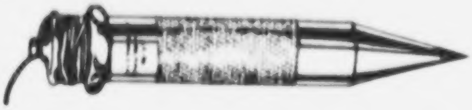
Hook rule



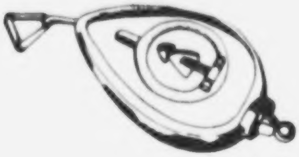
G. Levels: devices used to check surfaces for true alignment horizontally, vertically or at a 45-degree angle



H. Plum bob: used to check related members for alignment or plumb. Cord or string length varies, and common weights are 6-24 ounces.



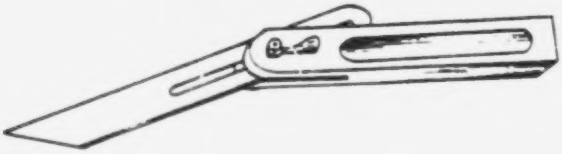
I. Chalk line: chalk-coated line stretched tightly and snapped sharply to mark a straight line between two points; can also be used to check for straightness in plate and structural metals

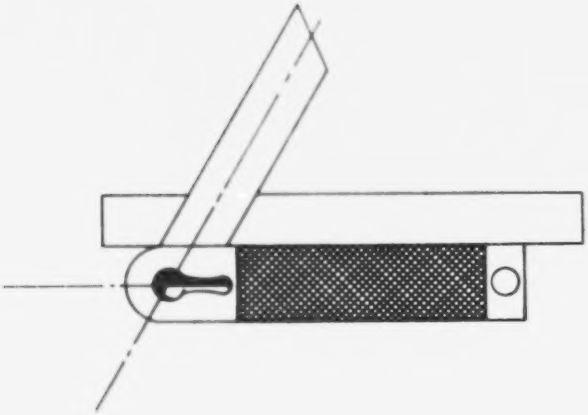


J. Center punch: used to make puncture marks, to locate centers of holes or to establish work points or center lines on material

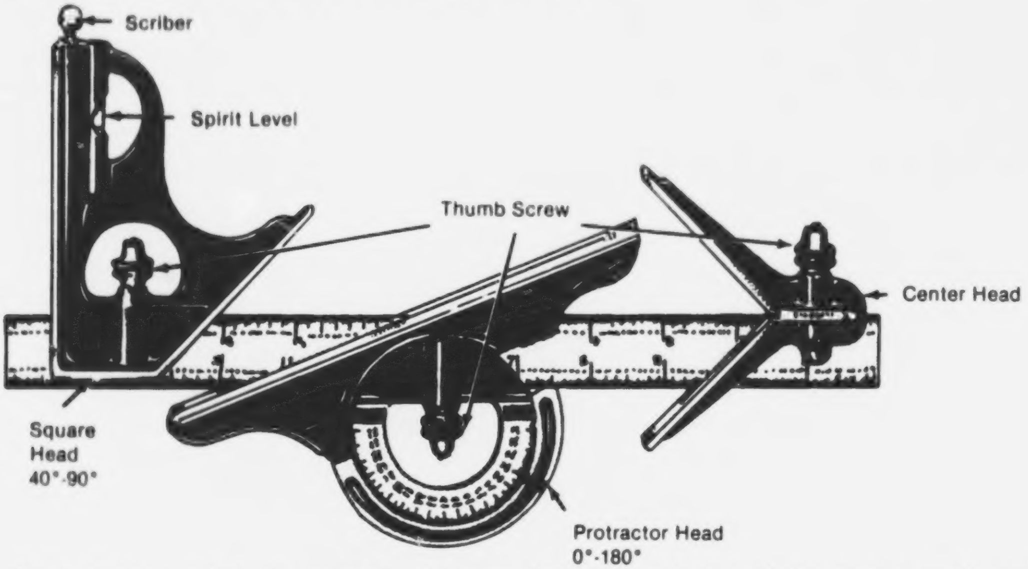
K. Prick punch: used most often to make punch marks along layout lines to provide permanent references for chalked or scribed lines that might wear off in handling

L. Bevel square: used to lay out bevel lines or check materials cut on a bevel; can be adjusted to all angles

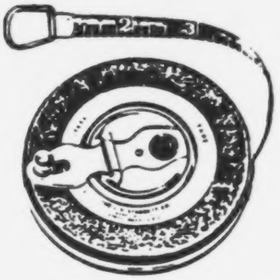




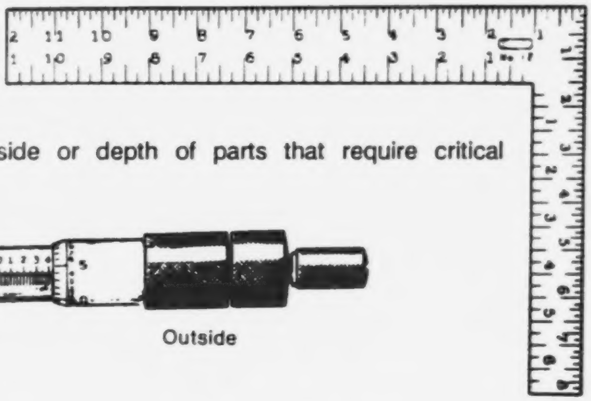
M. Combination square: used to square detail material. Square head is used for 45-degree and 90-degree angles. Protractor head is used to read angles from 0 to 180 degrees. Center head is used to find the center round materials.


Scriber
Spirit Level
Thumb Screw
Center Head
Square Head 40°-90°
Protractor Head 0°-180°

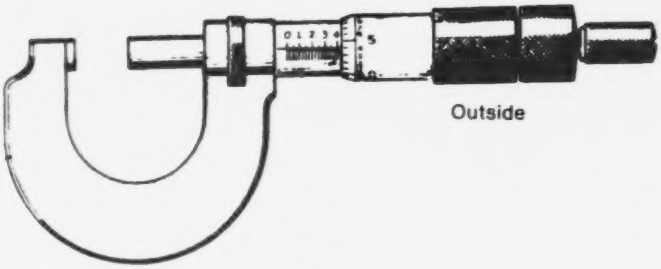
N. Steel tapes: used to measure distances between points and for layout work and squaring; generally longer than 25'

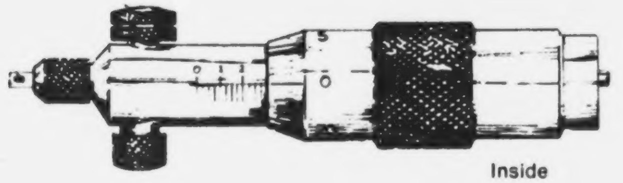


O. Framing square: used primarily by fitters to check trueness of flanges and angles; is also used for setting and checking bevel squares. Edges marked with rule-like graduations make it a good measuring tool.



P. Micrometers: used to measure inside, outside or depth of parts that require critical tolerances

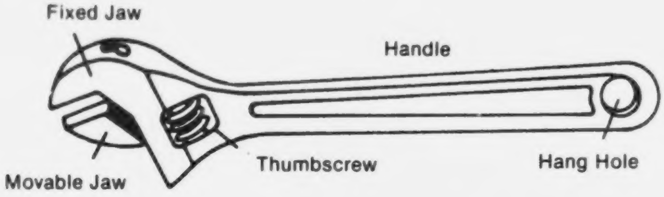




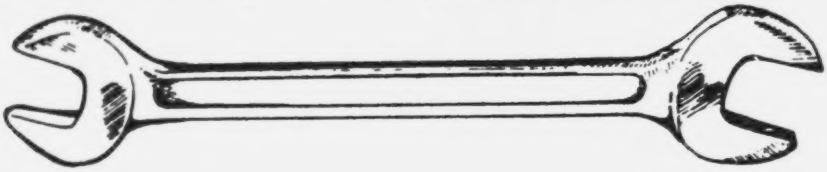
Inside

II. Turning tool and wrench uses

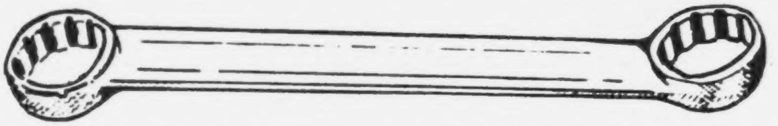
A. Adjustable wrench (crescent wrench): used to tighten or loosen different sizes of nuts and bolts


Fixed Jaw
Handle
Thumbscrew
Hang Hole
Movable Jaw

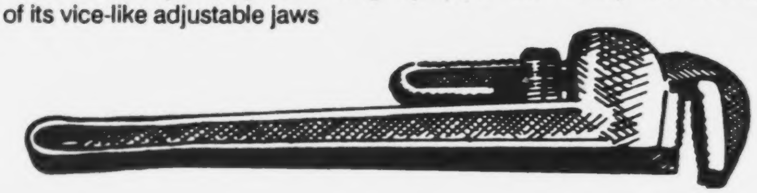
B. Open-end wrench: used to tighten or loosen specific sizes of nuts and bolts



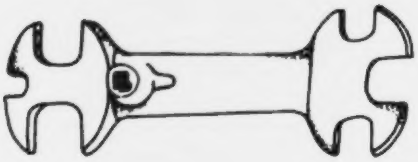
C. Box-end wrench: used to tighten or loosen specific sizes of nuts and bolts



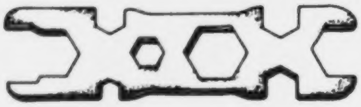
D. Pipe wrench: used primarily for fitting up pipe but handy for holding and aligning because of its vice-like adjustable jaws



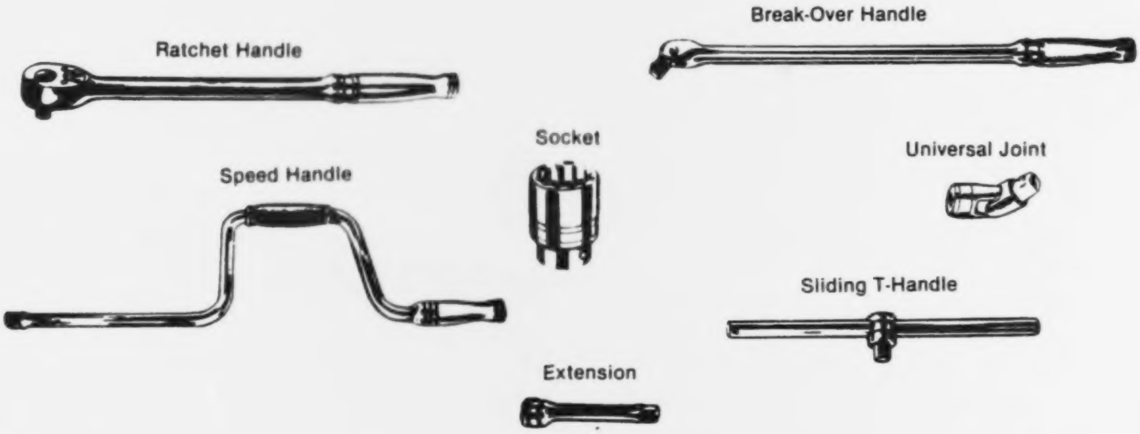
E. Cylinder wrenches: used specifically for tightening or loosening cylinder connections on oxy-acetylene equipment because adjustable wrenches can easily damage the brass fittings



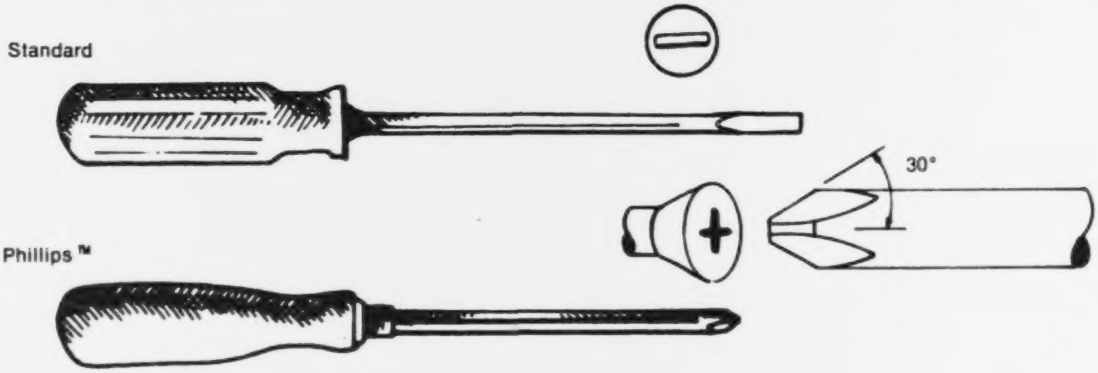
F. Torch wrenches: used specifically for tightening or loosening torch connections where the use of adjustable wrenches or pliers might damage brass fittings



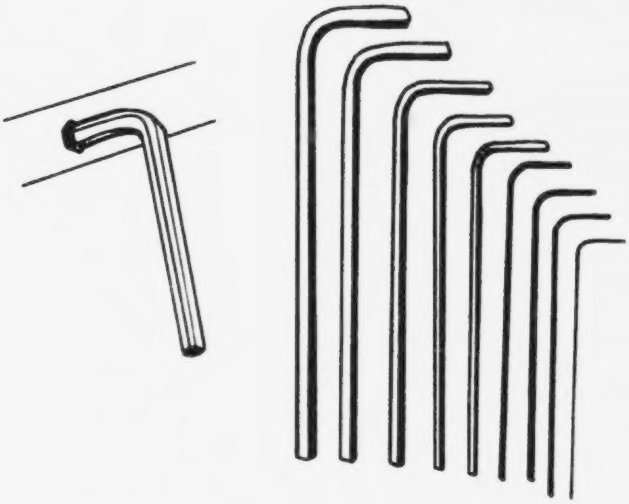
G. Socket wrench and handles: used to tighten or loosen specific sizes of nuts and bolts with a variety of socket sizes and handles for various jobs


Break-Over Handle
Ratchet Handle
Socket
Universal Joint
Speed Handle
Sliding T-Handle
Extension

H. Screwdrivers: used to tighten or loosen specific types of screws, bolts and other anchoring devices. Common types are standard and Phillips™.


Standard
30°
Phillips ™

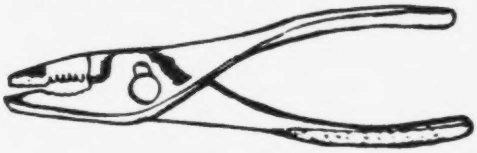
I. Allen wrenches: hex-shaped key-type wrenches used to tighten or loosen specific sizes of Allen screws or bolts



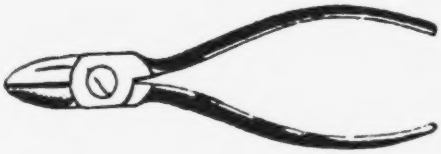
III. Uses of manual cutting and shaping tools

A. Pliers

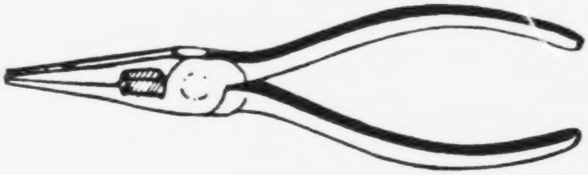
1. Slip joint: used for handling hot metal or materials



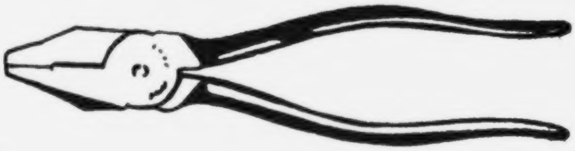
2. Diagonal cutters: frequently used in GMAW welding and for cutting small-diameter wire



3. Needle nose: used for cleaning cups and nozzles, cutting small-diameter wire, holding and bonding; used mostly in GMAW welding

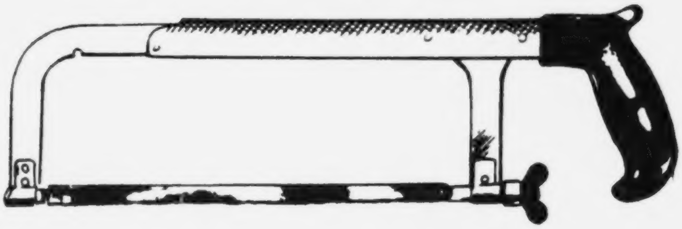


4. **Lineman's (side cutters):** used for holding and to cut larger-diameter wire; used in submerged arc welding

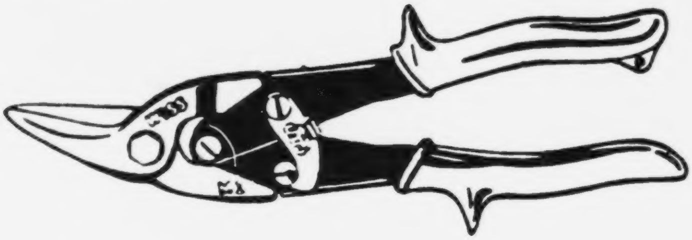


B. Other manual cutting and shaping tools

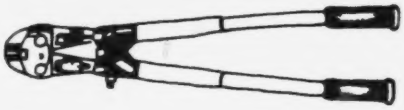
1. Hacksaw: used to cut or separate metal manually



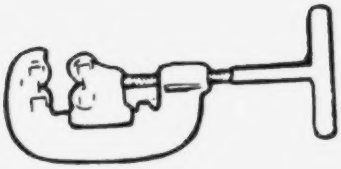
2. Straight-cut snips: used to cut straight lines or curves on light-gauge metal; also available in left or right cuts



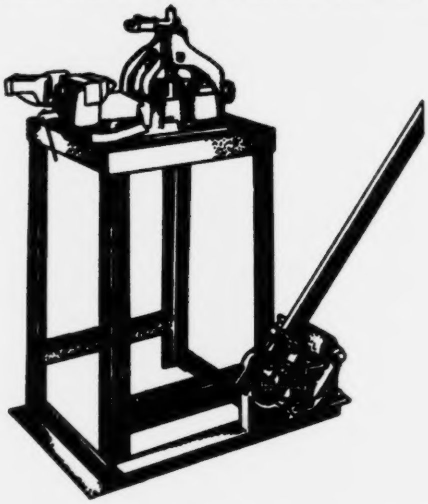
3. Bolt cutters: used to cut small-diameter nuts, bolts, rod and chain



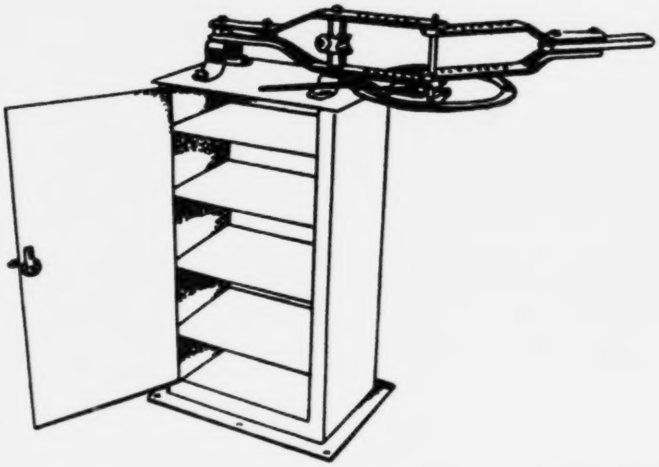
4. Pipe cutters: used for cutting small-diameter pipe or tubing



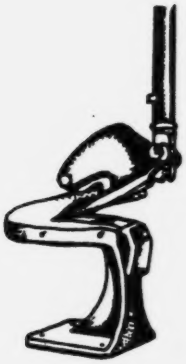
5. Angle iron cutter, notcher and bender: used to cut, notch and bend angle iron



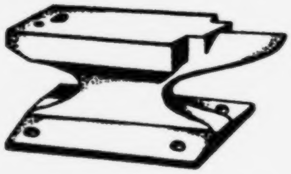
6. Hossfeld bender: used to bend, form and shape pipe, tubing, angle iron, flat bars and straps



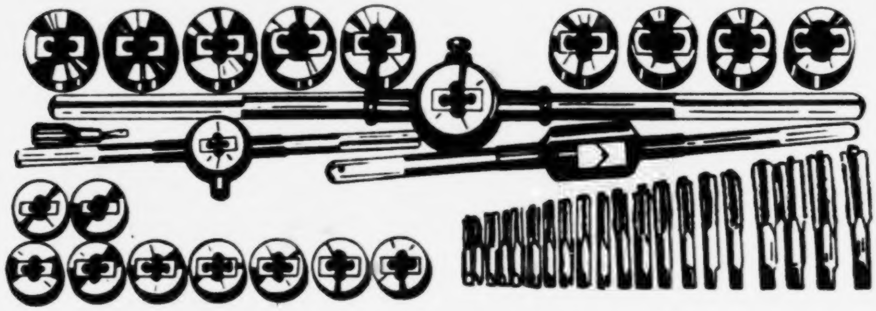
7. Beverly shear: lever-operated bench tool that makes distortion-free cuts in straight or curved patterns on light to heavy metals



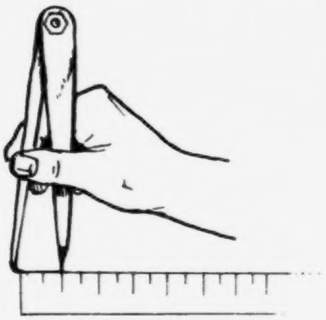
8. Anvil: an iron or steel block with both flat and curved surfaces for shaping metals that are hammered or peened against it. It sometimes has a tapered round end for curving metal strapping and other materials



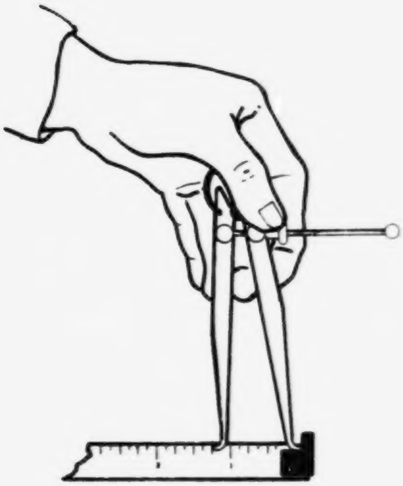
9. Taps and dies: tools used to cut female threads (taps) in metal or to cut threads on the outside (dies) of pipes or other round stock; usually available in sets.



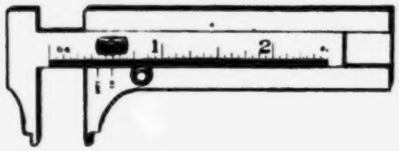
TYPES OF CALIPERS



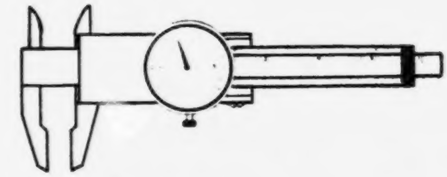
Hermaphrodite Caliper



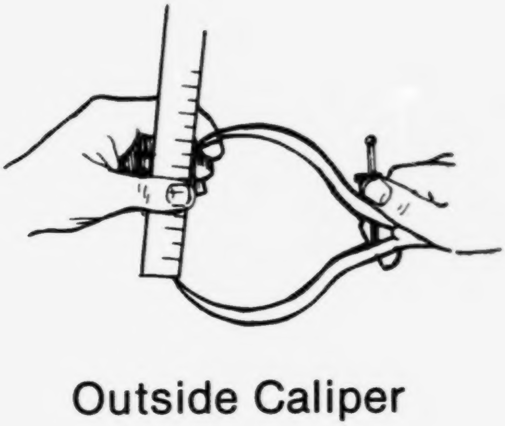
Inside Caliper



Slide Caliper Rule



Dial Caliper



Outside Caliper

AS 3.1

MEASURING, TURNING AND CUTTING TOOLS

Match tool characteristics and uses with the corresponding tools.

____ 1. Measure gauges; set lines, holes, work points and many other straight line measurements up to 25'; made to be carried on a welder's belt

____ 2. Measure gauge thickness of sheet metal, plate and wire

____ 3. Help assure that drill tips being sharpened are kept centered at an angle of 59 degrees

____ 4. Transfer measurements and construct small circles and arcs

____ 5. Inside and outside measurements

____ 6. Measuring devices graduated in whole units and fractions for distances up to 48 inches

____ 7. Check surfaces for true alignment horizontally, vertically or at a 45-degree angle

____ 8. Check related members for alignment or plumb; cord or string length varies

____ 9. Chalk-coated line stretched tightly and snapped sharply to mark a straight line

____ 10. Make puncture marks, locate hole centers or establish work points

____ 11. Most often used to make punch marks along layout lines for permanent reference

____ 12. Lay out bevel lines or check materials cut on a bevel; adjustable

____ 13. Square detail material; has a square protractor head and center head

____ 14. Measure distances between points; used for layout work and for squaring pieces generally longer than 25'

a. American & U.S. standard metal gauges

b. Bevel squares

c. Calipers

d. Center punches

e. Chalk lines

ab. Combination squares

ac. Drill point gauges

ad. Levels

ae. Plumb bobs

bc. Pocket tapes

bd. Prick punches

be. Rules

cd. Steel tapes

ce. Wing dividers

Match tool characteristics and uses with the corresponding tools.

____ 15. Primarily used by fitters to check flange and angle trueness. Edges marked with rule-like gradations
____ 16. Measures inside, outside or depth of parts that require critical tolerances
____ 17. Tightens or loosens different sizes of nuts and bolts
____ 18. Tightens or loosens specific sizes of nuts and bolts
____ 19. Fitting up pipe; has vice-like, adjustable jaws
____ 20. Specifically for tightening or loosening cylinder connections on oxy-acetylene equipment
____ 21. Specifically for tightening or loosening torch connections
____ 22. Tightens or loosens specific sizes of nuts and bolts; a variety of socket sizes and handles
____ 23. Tightens or loosens specific types of screws, bolts and other anchoring devices
____ 24. Hex-shaped, key-type wrenches used to tighten or loosen specific sizes of screws or bolts
____ 25. Used for handling hot metal or materials
____ 26. Cutting small-diameter wire; frequently used in GMAW welding
____ 27. Cleaning cups and nozzles; cutting small-diameter wire; holding; and bonding--mostly in GMAW welding
____ 28. Cut larger diameter wire in submerged arc welding

a. Adjustable wrench
b. Allen wrench
c. Box-end wrench
d. Cylinder wrench
e. Diagonal cutters
ab. Framing square
ac. Lineman's pliers
ad. Micrometer
ae. Needle-nose pliers
bc. Pipe wrench
bd. Screwdriver
be. Slip-joint pliers
cd. Socket wrench and handles
ce. Torch wrench

Match tool characteristics and uses with the corresponding tools.

____ 29. Cut or separate metal manually
____ 30. Cut straight lines or curves on light-gauge metal; also available in left or right cuts
____ 31. Cut small-diameter nuts, bolts, rod and chain
____ 32. Cut small-diameter pipe or tubing
____ 33. Cut, notch and bend angle iron
____ 34. Bend, form and shape pipe, tubing, angle iron, flat bars and straps
____ 35. Lever-operated bench tool that makes distortion-free cuts in straight or curved patterns
____ 36. Iron or steel block with flat and curved surfaces for shaping metals that are hammered or peened against it
____ 37. Cut female threads in metal or threads on the outside of pipes or other stock

a. Angle iron cutter, notcher and bender
b. Anvil
c. Beverly shear
d. Bolt cutter
e. Hacksaw
ab. Hossfeld bender
ac. Pipe cutters
ad. Straight-cut snips
ae. Taps and dies

INSTRUCTOR'S NOTE: Completion of this assignment to a specified score is the student's partial evaluation for competencies A6 and A10 and final evaluation for A9.

ANSWERS TO ASSIGNMENT SHEET 3.1

1. bc
2. a
3. ac
4. ce
5. c
6. be
7. ad
8. ae
9. e
10. d
11. bd
12. b
13. ab
14. cd
15. ab
16. ad
17. a
18. c
19. bc
20. d
21. ce
22. cd
23. bd
24. b
25. be
26. e
27. ae
28. ac
29. e
30. ad
31. d
32. ac
33. a
34. ab
35. c
36. b
37. ae

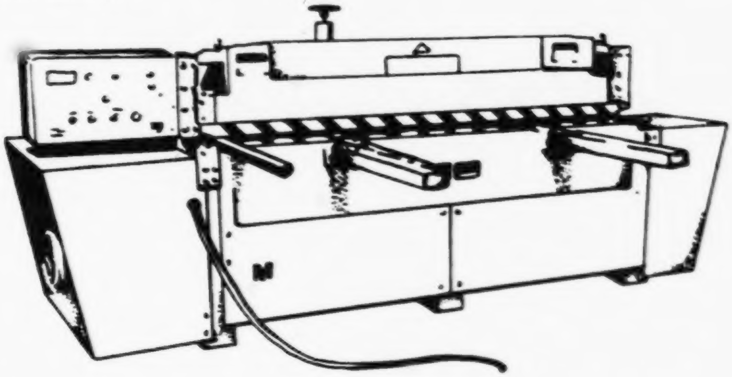
MODULE: BASIC WELDING SKILLS

UNIT V: WELDING TOOLS AND EQUIPMENT

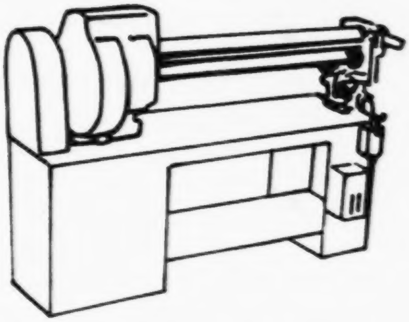
LESSON 4: POWER EQUIPMENT

I. Characteristics and uses of power equipment

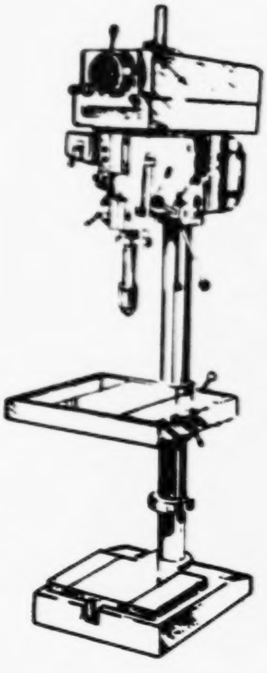
A. Power shears: used to cut all gauges of metal; may be operated mechanically, hydraulically or pneumatically.



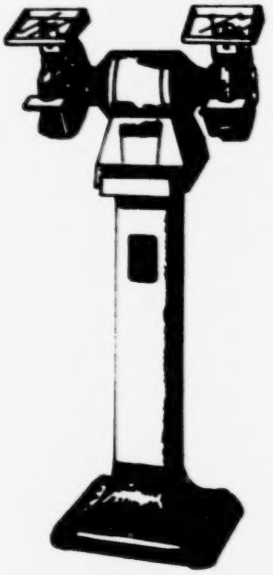
B. Power roll: used to shape both plate and structural metals into rounded forms



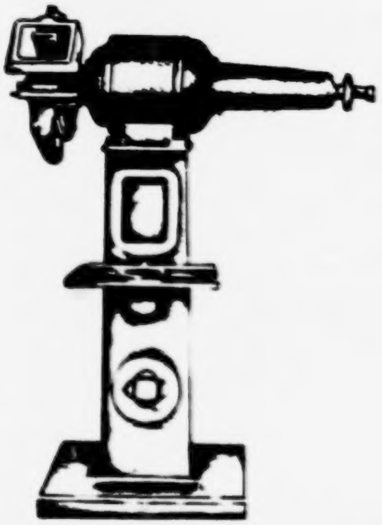
C. Drill press: used for drilling holes in several pieces of metal at one time or drilling single holes in heavier metals



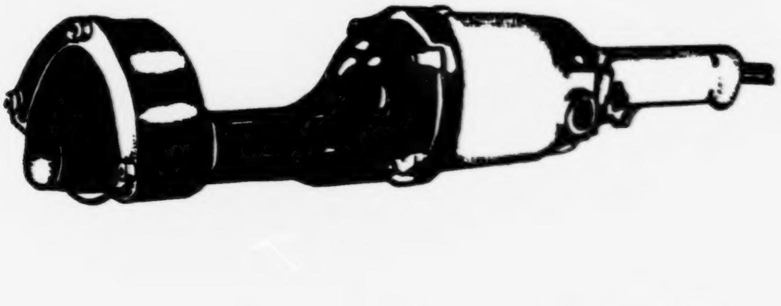
D. Pedestal grinder: used for grinding all forms of metal

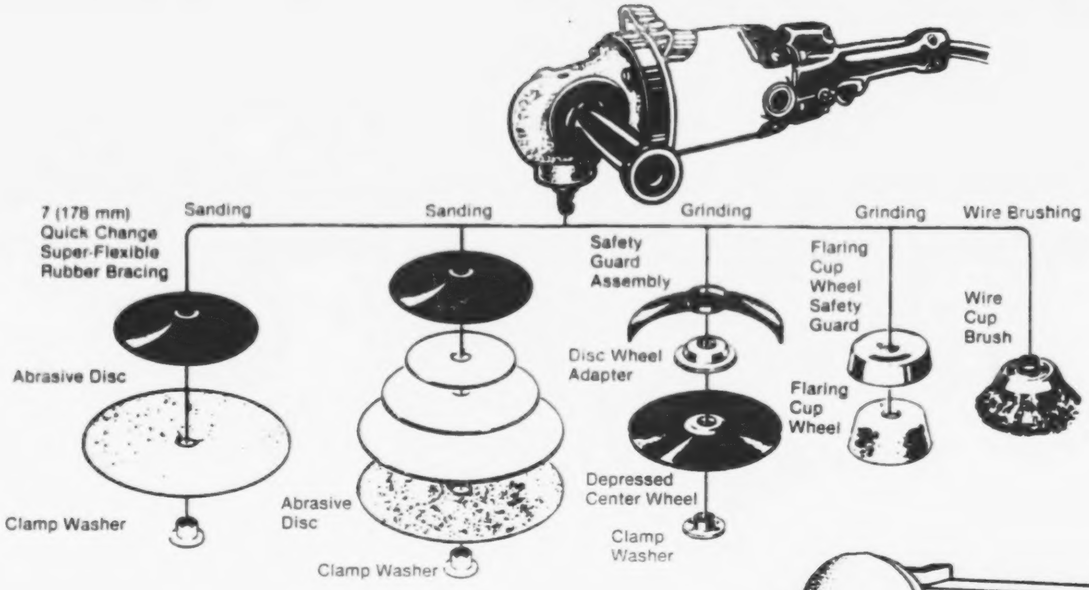


E. Pedestal buffer: used to polish or buff metals with wire, brush or cloth wheels

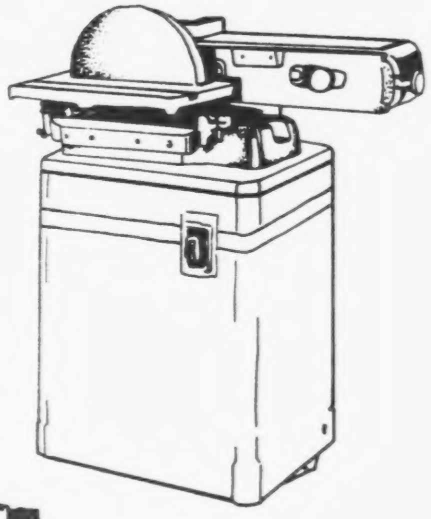


F. Angle and straight grinders: generally used with attachments for cleaning joints before or after a welding process

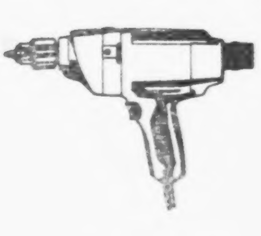



7 (178 mm)
Quick Change
Super-Flexible
Rubber Bracing
Sanding
Sanding
Grinding
Grinding
Wire Brushing
Safety Guard Assembly
Flaring Cup Wheel Safety Guard
Wire Cup Brush
Abrasive Disc
Disc Wheel Adapter
Flaring Cup Wheel
Depressed Center Wheel
Abrasive Disc
Clamp Washer
Clamp Washer
Clamp Washer

G. Belt and disc sander: used to grind or sand flat metal surfaces

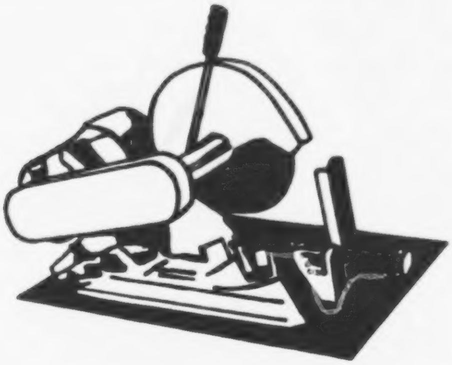


H. Hand drill: generally used for light drilling jobs. They come in several types, such as variable-speed and reversible and in 1/4", 3/8" and 1/2" sizes.

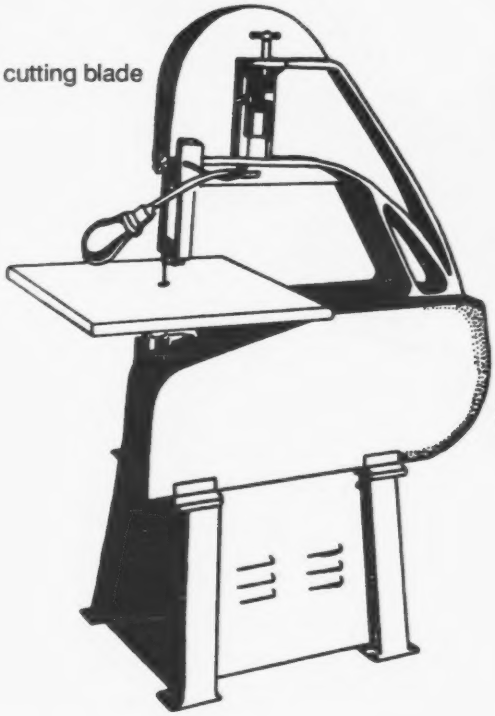


I. Heavy-duty hand drill: generally used for drilling thicker materials. They come in several types such as variable-speed and reversible, and in 1/2", 3/4" and 1 1/4" sizes.

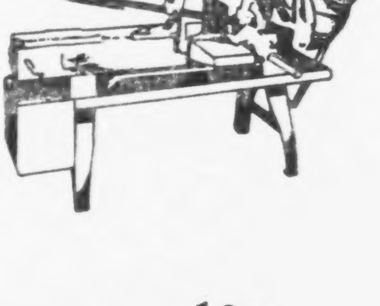
J. Cut-off saw: used to cut heavier metal at different angles or in straight cuts



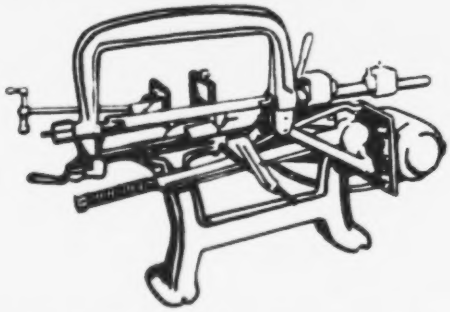
K. Vertical band saw: used for cutting metal with a continuous cutting blade



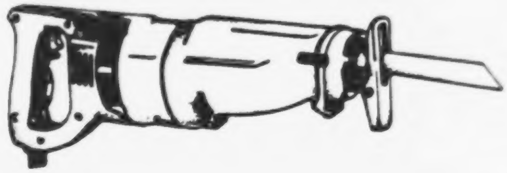
L. Horizontal band saw: used to cut any length or type of metal with a continuous cutting blade



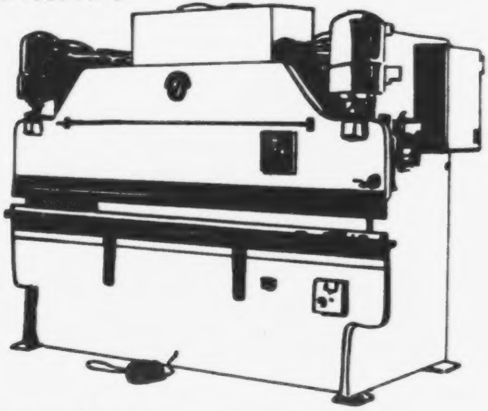
M. Power hacksaw: used to cut any length or type of metal



N. Reciprocating saw: used like a key-hole saw with various types of blades to cut wood, metal, plastic and even heavy steel

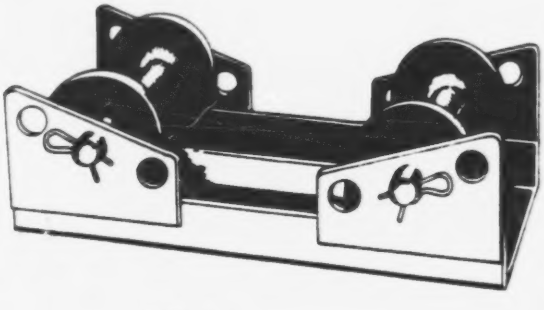


O. Press brake: used to press metal into varying shapes with different dies and punches and has capacities of more than 300 tons

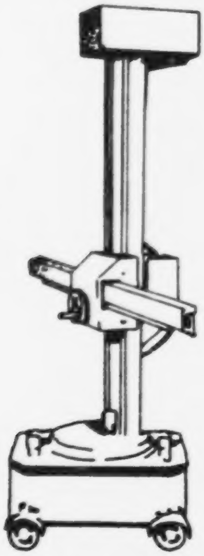


II. Characteristics and uses of positioning equipment

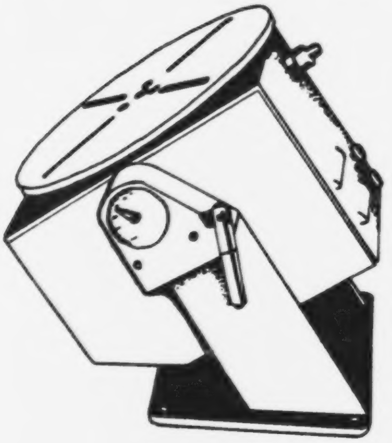
A. Turning rolls: used to roll pipes or round objects; typically used in production shops with automatic welding processes



B. Manipulators: used to control and position welding equipment on automatic positioners or turning rolls; typically used in production shops with automatic welding processes



C. Positioners: used to secure and position objects being welded. They can turn or rotate objects at preset speed or be controlled manually by operator. They are typically used in a production shop.



140

III. Basic rules for safe use of power tools and equipment

A. Do not use power tools until you have been instructed how to use them safely and have permission from your instructor.

B. Check electrical cords and plugs before using electrical power tools. Check lines and connections before using air-operated tools.

C. When working with a drill press, always clamp the workpiece in place to prevent spinning with the drill bit.

D. Make sure shields and guards are securely in place before using power equipment.

E. Avoid walking into restricted safety zones marked off around power equipment.

F. When using extension cords with power equipment, make sure they are grounded and free of breaks or frays.

G. Do not wear loose or frayed clothing around rotating equipment.

H. Pay attention to safety signs and warning tags.

I. Know emergency shut-down procedures for all power equipment.

J. Keep tools clean and dry.

IV. Basic rules for maintaining tools and equipment

A. The No. 1 rule is to use it only for its intended purpose(s).

B. Tag and report any tool or piece of equipment suspected of being faulty.

C. Properly record and date information placed on lubrication and maintenance schedules.

D. Always disconnect the power supply when performing maintenance on power tools and equipment.

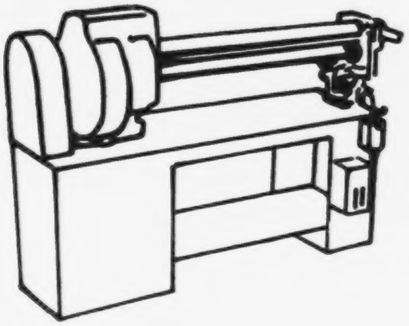
E. Check tool rests on pedestal grinders daily.

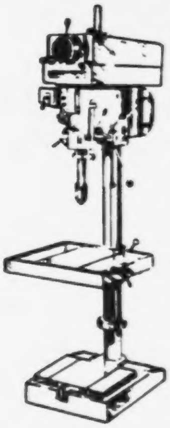
F. Check grinding wheels daily and dress as needed.

G. Check oil pressure on shears before using them.

POWER EQUIPMENT

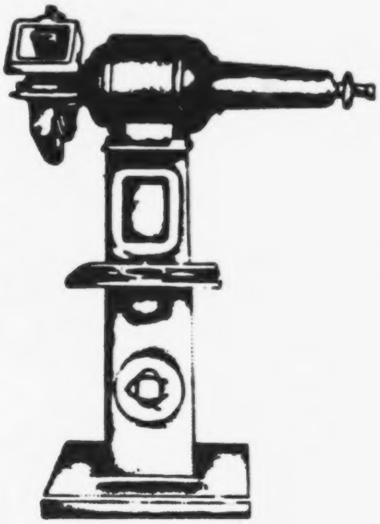
Write the name of the power tool or piece of power equipment below each illustration.

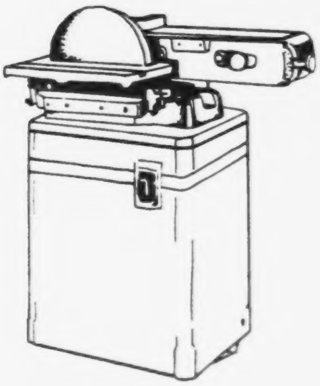




1. ______________________

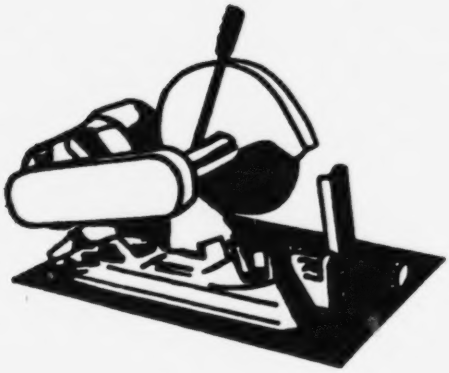
2. ______________________

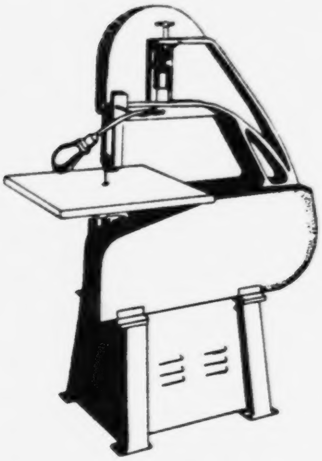




3. ______________________

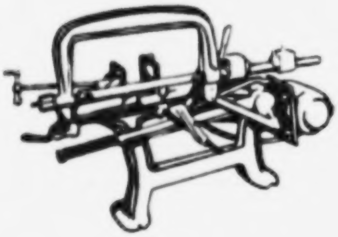
4. ______________________

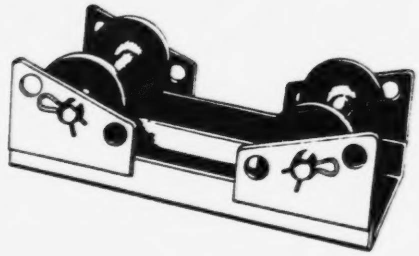




5. ______________________

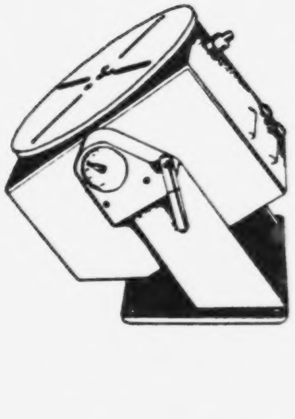
6. ______________________

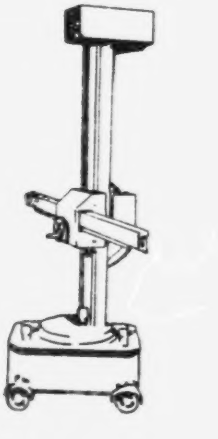




7. ______________________

8. ______________________





9. ______________________

10. ______________________

ANSWERS TO ASSIGNMENT SHEET 4.1

1. Power roll
2. Drill press
3. Pedestal buffer
4. Belt and disc sander
5. Cut-off saw
6. Vertical band saw
7. Horizontal band saw
8. Turning roll
9. Positioner
10. Manipulator

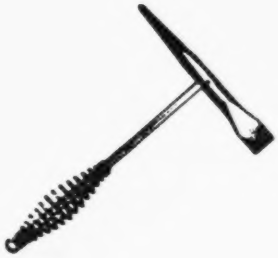
MODULE: BASIC WELDING SKILLS

UNIT V: WELDING TOOLS AND EQUIPMENT

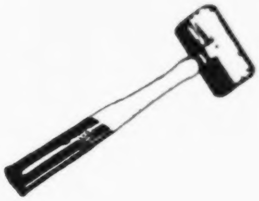
UNIT TEST

Identify these hand tools by labeling the picture with the letter that corresponds to the tool's name.

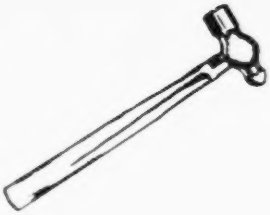
a. Ball-peen hammer
b. C-clamp
c. Card file
d. Chipping hammer
e. Cold chisel
ab. Combination square
ac. Come-along
ad. Drift punch
ae. Mallet
bc. Plumb bob
bd. Self-contained hydraulic jack
be. Spring clamp
cd. Strongback
ce. Turnbuckle
de. Wedge



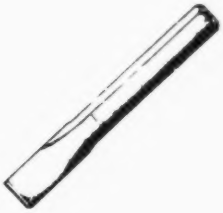
1. ________



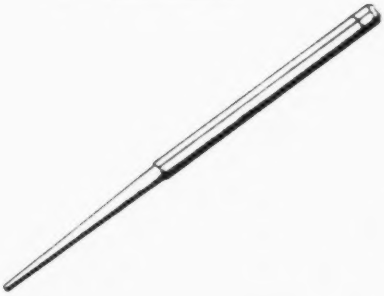
2. ________



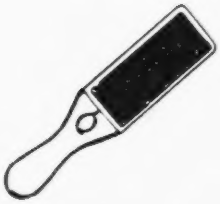
3. ________



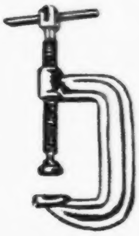
4. ________



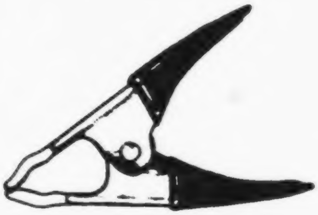
5. ________



6. ________

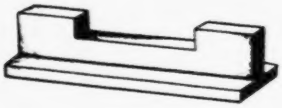


7. ________

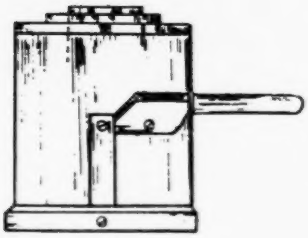


8. ________

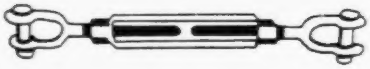
9. ________



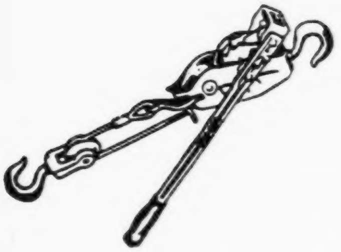
10. ________



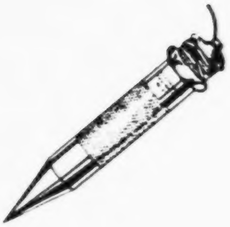
11. ________



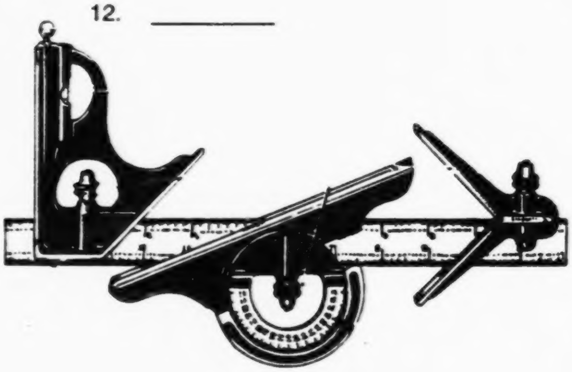
12. ________



13. ________



14. ________



15. ________

Match power equipment with appropriate characteristics and uses.

____ 16. Cut all gauges of metal; may be operated mechanically, hydraulically or pneumatically
____ 17. Shape both plate and structural metals into rounded forms
____ 18. Drill holes in several pieces of metal at one time; drill single holes in heavy metals
____ 19. Grind all forms of metal
____ 20. Polish or buff metals with wire, brush or cloth wheels
____ 21. Used with attachments for cleaning joints before or after a welding process
____ 22. Grind or sand flat metal surfaces
____ 23. Light drilling jobs; come in several types, such as variable-speed and reversible
____ 24. Drilling thicker materials; several types and 1/2", 3/4" and 1 1/4" sizes
____ 25. Cut heavier metal at different angles or in straight cuts
____ 26. Cut mild steel with a continuous cutting blade
____ 27. Horizontal band saw used to cut any length or type of metal with a continuous cutting blade
____ 28. Cut any length or type of metal
____ 29. Used like a key-hole saw with various types of blades to cut wood, metal, plastic and heavy steel
____ 30. Press metal into varying shapes with different dies and punches; capacity of 300 tons

a. Angle and straight grinders
b. Belt and disc sanders
c. Cut-off saws
d. Drill presses
e. Hand drills
ab. Heavy-duty hand drills
ac. Horizontal band saws
ad. Pedestal buffers
ae. Pedestal grinders
bc. Power hacksaws
bd. Power rolls
be. Power shears
cd. Press brakes
ce. Reciprocating saws
de. Vertical band saws

Choose the option which best answers the question or completes the statement.

____ 31. Use power tools _____ .

a. Anytime a job needs to be done quickly
b. In late morning or afternoon to disturb fewer people
c. After proper instruction and permission has been granted
d. Quickly so the next person has an opportunity, too

____ 32. When using any electrical power tools, _____ .

a. Put on an apron to keep clothes clean
b. First check electrical cords and plugs
c. Flip on the switch to see if the machine works OK
d. Wear a heavily shielded safety mask

____ 33. When working with a drill press, always clamp the workpiece in place to _____.

a. Make sure the hole is drilled accurately
b. Free your hands for other work
c. Make sure the drill bit spins properly
d. Prevent spinning with the drill bit

____ 34. Make sure _____ are securely in place before using power equipment.

a. Workpieces and lights
b. Hangtags
c. Floormats
d. Shields and guards

____ 35. Avoid walking into _____ around power equipment.

a. Restricted safety zones marked off
b. Blue zones
c. Ivory zones
d. Green zones

____ 36. Clothing, when working around rotating equipment, should be ____.

a. Bright colored
b. Stylish
c. Free from fraying or tears
d. Dull colored

____ 37. The primary rule for maintaining a tool or piece of equipment is to ____ .

a. Use it for any applicable purpose
b. Treat it carefully--tools are expensive
c. Make sure the area is not congested
d. Use it only for its intended purpose

____ 38. When not in use, electrodes are particularly susceptible to ____.

a. Light
b. Moisture
c. Heat
d. Dust
e. None of the above

____ 39. What is a good way to protect electrodes?

a. Keep packaged until ready to use.
b. Keep broken packages in moisture-proof containers.
c. Dry electrodes in electrode ovens before use.
d. All of the above

NOTE: Completion of this unit test to a specified score is the student's partial evaluation for A10 and final evaluation for competencies A6, A11 and A12.

ANSWERS TO UNIT TEST

1.	d	(A10)
2.	ae	(A10)
3.	a	(A10)
4.	e	(A10)
5.	ad	(A10)
6.	c	(A10)
7.	b	(A10)
8.	be	(A10)
9.	de	(A10)
10.	cd	(A10)
11.	bd	(A10)
12	ce	(A10)
13.	ac	(A10)
14.	bc	(A10)
15.	ab	(A10)
16.	be	(A11)
17.	bd	(A11)
18.	d	(A11)
19.	ae	(A11)
20.	ad	(A11)
21.	a	(A11)
22.	b	(A11)
23.	e	(A11)
24.	ab	(A11)
25.	c	(A11)
26.	de	(A11)
27.	ac	(A11)
28.	bc	(A11)
29.	ce	(A11)
30.	cd	(A11)
31.	c	(A11)
32.	b	(A6)
33.	d	(A6)
34.	d	(A11)
35.	a	(A11)
36.	c	(A6)
37.	d	(A6)
38.	b	(A12)
39.	d	(A12)

MODULE: BASIC WELDING SKILLS

UNIT VI: MATH AND MEASUREMENT

UNIT OBJECTIVES

Upon completion of this unit, the student should be able to apply math to the solution of welding problems. These problems will involve using whole numbers, fractions, decimals, geometry and trigonometry. The student will also be able to use reference books and charts to solve problems. This knowledge will be evidenced by achieving the specified score on the unit test.

SPECIFIC OBJECTIVES

1.1 Solve problems using the English-metric conversion chart.

1.2 Make conversions with the decimal equivalent and inches-to-decimal conversion charts.

1.3 Demonstrate ability to:

  a. Adjust bevel square to a 45-degree angle.

  b. Use combination square to form 90- and 45-degree angles

2.1 Find the midpoint of lines and figures.

2.2 Calculate perimeters for rectangles, squares and triangles.

3.1 Identify basic geometric figures.

3.2 Calculate the areas of basic geometric figures (parallelograms, rectangles, squares, triangles, rhombuses and trapezoids).

3.3 Find the measurement of a triangle's sloping side.

3.4 Calculate the circumferences and areas of circles.

4.1 Size commonly used steel stock from scale drawings.

MODULE: BASIC WELDING SKILLS

UNIT VI: MATH AND MEASUREMENT

CONTENTS OF THIS UNIT

A. Objective sheets

B. References

C. Notes to the instructor

D. Lesson plans

1. Lesson 1: MEASUREMENT AND CONVERSIONS

    a. Pre-test

    b. Handouts

        HO 1.1: Decimal equivalent chart
        HO 1.2: Inches-to-decimal conversion (part of a foot)
        HO 1.3: English-metric conversion chart

    c. Assignment sheet

        AS 1.1: Making conversions with charts

    d. Job sheets

        JS 1.1: Adjust bevel square to a 45-degree angle
        JS 1.2: Use combination square to form 90- and 45-degree angles

2. Lesson 2: MIDPOINTS AND PERIMETERS

    a. Information outline

    b. Assignment sheets

        AS 2.1: Find the midpoint of lines and figures
        AS 2.2: Calculate perimeters of rectangles and squares
        AS 2.3: Calculate perimeters of triangles

    c. Answers to assignment sheets

3. Lesson 3: GEOMETRIC FIGURES

    a. Information outline

    b. Assignment sheets

        AS 3.1: Calculate the areas of parallelograms, rectangles and squares
        AS 3.2: Calculate the areas of triangles, rhombuses and trapezoids
        AS 3.3: Calculate the circumferences and areas of circles

4. Lesson 4: SIZING STEEL
    a. Information outline

E. Unit test

F. Answers to unit test

REFERENCES

A. Books

1. Brown, Walter C. Drafting for Industry. South Holland, Ill.: The Goodheart-Willcox Company, Inc., 1974.

2. Giesecke, Frederick E., et al. Technical Drawing. New York: Macmillan Publishing Co., Inc., 1980.

3. Slade, Margolis and Boyce. Mathematics for Technical and Vocational Schools, 5th edition. New York: John Wiley and Sons, 1968.

B. Curriculum guides

1. Introduction to Welding. Stillwater, Okla.: Mid-America Vocational Curriculum Consortium, Inc., 1984.

NOTES TO THE INSTRUCTOR

A. Suggested approaches to teaching this unit

1. Instead of lengthy information sheets over basic math skills, a pre-test has been included in Lesson 1 to assist the instructor in determining which students need remedial math assistance. Students who complete the pre-test to a specified level may progress to the assignment sheets and job sheets. Those who do not pass should work through exercises on whole numbers, fractions and decimals in the Vocational Math guide or other approved math text (see references).

B. Suggested student activities

1. Out of class, students can practice welding math and measurement.

2. Measurement samples can be made and used from year to year.

C. Suggested supplemental materials

1. Texts

    a. Shell and Matlock. Practical Problems in Mathematics for Welders. New York: Delmar, 1982.

    b. Welding Supplementary Units. Columbia: Instructional Materials Laboratory, University of Missouri-Columbia, 1988.

2. Videotapes available from The Media Center, State Fair Community College, Sedalia, Mo.

    a. Basic Measurement: Using a Ruler (W-88-200)

    b. Formulas Used in the Welding Shop (W-88-205)

PRE-TEST, LESSON 1, UNIT VI

Choose the letter which corresponds to the problem's answer. Show all your work to the side of the problem or on a separate piece of paper.

Compute problems using fractions and decimals.

1. 1/2 + 3/4 = _____

   (a) 1 1/8 (b) 1 1/4 (c) 1 1/6 (d) 1 1/2

2. 3/4 + 5/8 + 9/16 + 5/32 = _____

   (a) 1 3/32 (b) 1 9/16 (c) 2 3/32 (d) 2 5/32

3. 7/8 - 3/4 = _____

   (a) 1/4 (b) 1/5 (c) 1/6 (d) 1/8

4. 1 9/16 - 3/4 = _____

   (a) 1 1/16 (b) 15/16 (c) 13/16 (d) 11/16

5. 5/8 x 3/4 = _____

   (a) 8/12 (b) 15/32 (c) 7/24 (d) 5/16

6. 5 5/16 x 4 = _____

   (a) 20 5/16 (b) 21 1/4 (c) 22 (d) 22 1/4

7. 3/4 3/8 = _____

   (a) 2 (b) 1/2 (c) 3/16 (d) 1/8

8. 2 1/2 5 = _____

   (a) 12 1/2 (b) 2 (c) 1/2 (d) 1/4

Reduce the following fractions to lowest terms.

9. 16/24 = _____

   (a) 2/3 (b) 4/6 (c) 3/4 (d) 8/12

10. 48/64 = _____

    (a) 3/4 (b) 12/16 (c) 3/5 (d) 3/8

Compute the following problems using decimals to the third or fourth decimal place.

11. 0.046 + 0.00002 + 0.653 + 8.1673 = _____

    (a) 9.8663 (b) 9.5 (c) 8.7663 (d) 8.8663

12. 0.5 + 0.015 + 0.171 + 8.7003 + 16.37 = _____

    (a) 26.7563 (b) 26.6563 (c) 25.8 (d) 25.7563

13. 8.763 - 0.041 =_____

(a) 8.722 (b) 8.622 (c) 8.721 (d) 7.722

14. 126.373 - 126.219 =_____

(a) 0.254 (b) 0.144 (c) 0.154 (d) 0.054

15. 0.9321 x 1.76 =_____

(a) 1.7405 (b) 1.6405 (c) 1.5405

(d) 1.64

16. 9.429 x 8.670 =_____

(a) 82.7494 (b) 81.8 (c) 81.7494

(d) 71.7494

17. 0.0672 28 =_____

(a) .24 (b).024 (c) .0034 (d) .0024

18. 73.16 24 =_____

(a) 3.0483 (b) 3.04 (c) 3.483 (d) 4.0483

Convert fractions to decimals. Show work.

19. 5/8 =_____

(a) 0.4 (b) 0.725 (c) 0.625 (d) 0.525

20. 1/8 =_____

(a) 0.1 (b) 0.125 (c) 0.12 (d) 0.225

21. 11/16 =_____

(a) 0.75 (b) 0.7375 (c) 0.6775

(d) 0.6875

Express each decimal as a fraction.

22. .8 = _____

(a) 3/4 (b) 8/9 (c) 4/5 (d) 5/6

23. .7 = _____

(a) 7/100 (b) 17/100 (c) 6/10 (d) 7/10

24. .68 = _____

(a) 16/25 (b) 17/24 (c) 17/25

(d) 19/25

Convert feet and inches to decimals.

25. 9' 6 3/4" =_____

(a) .956' (b) 9.56' (c) 9.66' (d) 9.7'

26. 3' 4 5/8" =_____

(a) 3.38' (b) 3.28' (c) 2.38' (d) 2.2'

27. 14' 2 1/4" =_____

(a) 14.19' (b) 14.18' (c) 14.09

(d) 14.1'

Convert decimals to feet and inches.

28. 2.5000' =_____

(a) 2'8" (b) 2'7" (c) 2'6" (d) 2'5"

29. 8.6333' =_____

(a) 8'6" (b) 8'6 3/5" (c) 8'7 3/5"

(d) 8'7"

30. 11.7425' =_____

(a) 11'7 9/10" (b) 11'8"

(c) 11'8 7/10" (d) 11'8 9/10"

Express each fraction as a percent.

31. 1/4 = _____

(a) 35% (b) 25% (c) 20% (d) 14%

32. 2/9 = _____

(a) 9% (b) 20% (c) 22% (d) 22.22%

Express each percent as a fraction.

33. 33 1/3% = _____

(a) 1/3 (b) .33 (c) 2/3 (d) 33/3

34. 36% = _____

(a) 36/1 (b) 8/25 (c) 9/25 (d) .36

35. 28% = _____

(a) 1/6 (b) 4/25 (c) 7/25 (d) .28

Express each percent as a decimal.

36. 45% = _____

(a) 4500 (b) 450 (c) 45.0 (d) .45

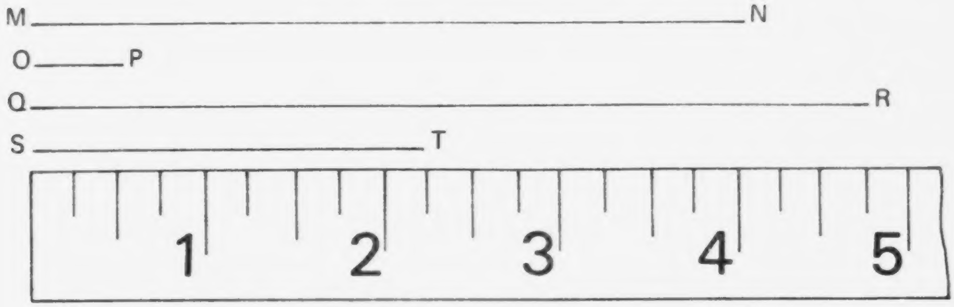
37. 15% = _____

(a) .15 (b) 15.0 (c) 150 (d) 1500

38. 62% = _____

(a) .062 (b) .62 (c) 6.2 (d) 62

Measure and record the length of these line segments.


M
N
O
P
Q
R
S
T
1
2
3
4
5

39. MN = _____

(a) 3 3/4" (b) 4" (c) 4 1/4" (d) 5"

40. OP = _____

(a) 1/8" (b) 1/5" (c) 1/4" (d) 1/2"

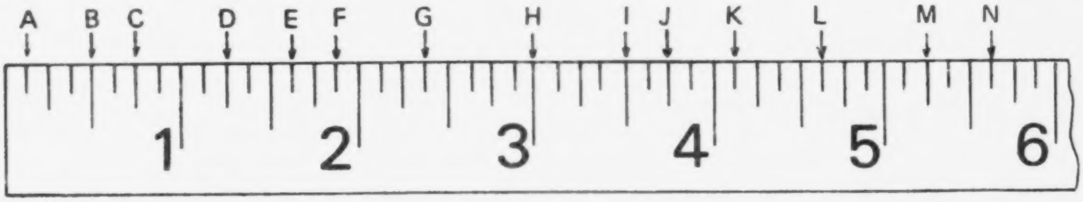
41. QR = _____

(a) 4 1/4" (b) 4 3/4" (c) 5" (d) 5 3/4"

42. ST = _____

(a) 1 1/4" (b) 2 1/8" (c) 2 1/4" (d) 2 3/4"

Use the drawing below to find the distance between the following letters. Give answers in lowest terms.


A
B
C
D
E
F
G
H
I
J
K
L
M
N
1
2
3
4
5
6

43. F to H = _____

(a) 1 1/8" (b) 1 7/8" (c) 1 1/4" (d) 3"

44. D to E = _____

(a) 1 7/8" (b) 1 1/4" (c) 3/4" (d) 3/8"

45. A to C = _____

(a) 1/2" (b) 5/8 (c) 3/4" (d) 7/8"

46. I to J = _____

(a) 3 3/4" (b) 3/4" (c) 1/4" (d) 1/8"

In the sketch at the right, find the measures of the lines below.

47. IH = ______

(a) 1/4" (b) 1/8" (c) 7/16" (d) 1/18"

48. IG = ______

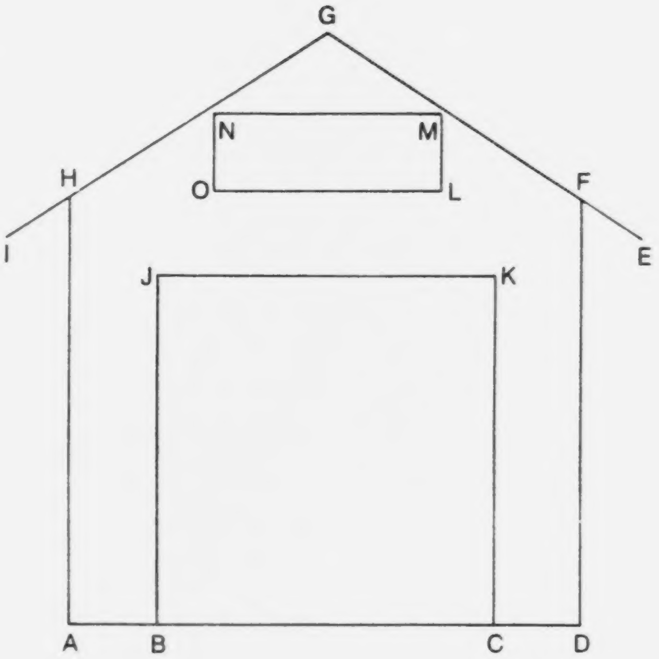
(a) 2 3/16" (b) 2 1/4"
(c) 2 4/16" (d) 2 5/16"

49. GE = ______

(a) 2 2/16" (b) 2 3/16"
(c) 2 1/4" (d) 2 4/16"

50. JK = ______

(a) 15/16" (b) 1 7/8"
(c) 1 14/16" (d) 1 15/16"



NOTE: Completion of this pre-test to specified level is the student's partial evaluation for competency A8: Apply math to solution of welding problems--whole numbers, fractions, decimals, geometry and trigonometry. Students who complete the pre-test with a specified score may advance to the assignment sheets and job sheets in this first lesson.

ANSWERS TO PRE-TEST

1. b
2. c
3. d
4. c
5. b
6. b
7. a
8. c
9. a
10. a
11. d
12. d
13. a
14. c
15. b
16. c
17. d
18. a
19. c
20. b
21. d
22. c
23. d
24. c
25. b
26. a
27. a
28. c
29. c
30. d
31. b
32. d
33. a
34. c
35. c
36. d
37. a
38. b
39. b
40. d
41. b
42. c
43. a
44. d
45. b
46. c
47. c
48. a
49. b
50. d

HO 1.1

DECIMAL EQUIVALENT CHART

1/64	.015625	33/64	.515625
1/32	.03125	17/32	.53125
3/64	.046875	35/64	.546875
1/16	.0625	9/16	.5625
5/64	.078125	37/64	.578125
3/32	.09375	19/32	.59375
7/64	.109375	39/64	.609375
1/8	.125	5/8	.625
9/64	.140625	41/64	.640625
5/32	.15625	21/32	.65625
11/64	.171875	43/64	.671875
3/16	.1875	11/16	.6875
13/64	.203125	45/64	.703125
7/32	.21875	23/32	.71875
15/64	.234375	47/64	.734375
1/4	.25	3/4	.75
17/64	.265625	49/64	.765625
9/32	.28125	25/32	.78125
19/64	.296875	51/64	.796875
5/16	.3125	13/16	.8125
21/64	.328125	53/64	.828125
11/32	.34375	27/32	.84375
23/64	.359375	55/64	.859375
3/8	.375	7/8	.875
25/64	.390625	57/64	.890625
13/32	.40625	29/32	.90625
27/64	.421875	59/64	.921875
7/16	.4375	15/16	.9375
29/64	.453125	61/64	.953125
15/32	.46875	31/32	.96875
31/64	.484375	63/64	.984375
1/2	.5	1	1.

INCHES-TO-DECIMAL CONVERSION (PART OF A FOOT)

Fractions of Inches	
1/16"	.0052
3/32"	.0078
1/8"	.0104
5/32"	.0130
3/16"	.0156
7/32"	.0182
1/4"	.0208
9/32"	.0234
5/16"	.0260
3/8"	.0313
7/16"	.0364
1/2"	.0417
9/16"	.0468
5/8"	.0521
11/16"	.0572
3/4"	.0625
13/16"	.0677
7/8"	.0729
15/16"	.0781

Inches	
1"	.0833
2"	.1667
3"	.2500
4"	.3333
5"	.4167
6"	.5000
7"	.5833
8"	.6667
9"	.7500
10"	.8333
11"	.9167
12"	1.0000

(Note: Do not confuse inches to decimal with decimal equivalents.)

ENGLISH-METRIC CONVERSION CHART

	When You Know	You Can Convert To	When You Multiply By
LENGTH	Inches	Millimeters (mm)	25.4
	Millimeters	Inches	0.04
	Inches	Centimeters (cm)	2.54
	Centimeters	Inches	0.4
	Inches	Meters (m)	0.0254
	Meters	Inches	39.37
	Feet	Centimeters	30.5
	Centimeters	Feet	4.8
	Feet	Meters	0.305
	Meters	Feet	3.28
	Miles	Kilometers (km)	1.61
	Kilometer	Miles	0.62
AREA	Inches^2	Millimeters^2 (mm^2)	645.2
	Millimeters^2	Inches^2	0.0016
	Inches^2	Centimeters^2 (cm^2)	6.45
	Centimeters^2	Inches^2	0.16
	Foot^2	Meters^2 (m^2)	0.093
	Meters^2	Foot^2	10.76
CAPACITY-VOLUME	Ounces	Milliliters (ml)	30
	Milliliters	Ounces	0.034
	Pints	Liters (l)	0.47
	Liters	Pints	2.1
	Quarts	Liters	0.95
	Liters	Quarts	1.06
	Gallons	Liters	3.8
	Liters	Gallons	0.26
	Cubic Inches	Liters	0.0164
	Liters	Cubic Inches	61.03
	Cubic Inches	Cubic Centimeters (cc)	16.39
	Cubic Centimeters	Cubic Inches	0.061
WEIGHT (MASS)	Ounces	Grams	28.4
	Grams	Ounces	0.035
	Pounds	Kilograms	0.45
	Kilograms	Pounds	2.2
FORCE	Ounce	Newtons (N)	0.278
	Newtons	Ounces	35.98
	Pound	Newtons	4.448
	Newtons	Pound	0.225
	Newtons	Kilograms (kg)	0.102
	Kilograms	Newtons	9.807

	When You Know	You Can Convert To	When You Multipy By
ACCELERATION	Inch/Sec^2	Meter/Sec^2	.0254
	Meter/Sec^2	Inch/Sec^2	39.37
	Foot/Sec^2	Meter/Sec^2 (m/s^2)	0.3048
	Meter/Sec^2	Foot/Sec^2	3.280
TORQUE	Pound-Inch (Inch Pound)	Newton-Meters (N-M)	0.113
	Newton-Meters	Pound-Inch	8.857
	Pound-Foot (Foot-Pound)	Newton-Meters	1.356
	Newton-Meters	Pound-Foot	.737
PRESSURE	Pound/sq. in. (PSI)	Kilopascals (kPa)	6.895
	Kilopascals	Pound/sq. in.	0.145
	Inches of Mercury (Hg)	Kilopascals	3.377
	Kilopascals	Inches of Mercury (Hg)	0.296
FUEL PERFORMANCE	Miles/gal	Kilometers/liters (km/l)	0.425
	Kilometers/liters	Miles/gal	2.352
VELOCITY	Miles/hour	Kilometers/hr (km/h)	1.609
	Kilometers/hour	Miles/hour	0.621
TEMPERATURE	Degrees Fahrenheit	Degrees Celsius	5/9 (F°-32)
	Degrees Celsius	Degrees Fahrenheight	9/5(C°)+32=F°

AS 1.1

MAKING CONVERSIONS WITH CHARTS

Using handouts when possible, give the decimal equivalent for the fractional sizes listed below.

1. 1/16 = ________
2. 7/8 = ________
3. 1/2 = ________
4. 9/16 = ________

Give the fractional size for the decimal equivalents listed below.

5. 0.4375 = ________
6. 0.3125 = ________
7. 0.125 = ________
8. 0.6875 = ________

Convert the following feet and inches to decimals, rounding off to the fourth decimal place.

9. 9' 6 3/4" = ________
10. 3' 4 5/8" = ________
11. 14' 2 1/4" = ________
12. 1' 6" = ________

Convert these decimals to feet and inches.

13. 2.5000' = ________
14. 8.6333' = ________
15. 11.7425' = ________
16. 17.1125' = ________

Locate the conversion factor and compute these problems. Show all work.

17. The wall thickness of a piece of steel tubing is 1/64". How many centimeters thick is the steel tubing?

18. A piece of steel round bar is 16' long. How many meters long is the round bar?

19. A bag of flux weights 50 pounds. How many kilograms does the bag of flux weigh?

INSTRUCTOR'S NOTE: Completion of this assignment sheet to a specified score is the student's partial evaluation for competency A7: Obtain and use reference books and charts.

ANSWERS TO AS 1.1

1. .0625
2. .875
3. .5
4. .5625
5. 7/16
6. 5/16
7. 1/8
8. 11/16
9. 9.56' or 9.5625'
10. 3.38' or 3.3853'
11. 14.19' or 14.1866'
12. 1.5'
13. 2' 6"
14. 8' 7 3/5"
15. 11' 8 9/10"
16. 17' 1/3/10"
17. 0.0396875 centimeters
18. 4.88 meters
19. 22.5 kilograms

JS 1.1

ADJUST BEVEL SQUARE TO A 45-DEGREE ANGLE

Equipment:

Bevel square
Framing square
Combination square
Protractor

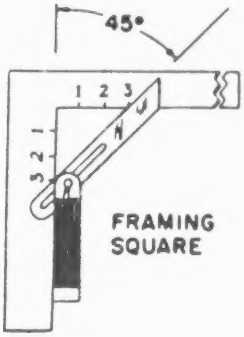
Procedure:

Evaluation
3 2 1 N

1. Place the framing square on a clean work area. Loosen the locking screw on the bevel square so that the blade moves with a slight friction. — — — —

2. Place the handle along the inside of the blade of the framing square so that it is straight against the framing square. — — — —

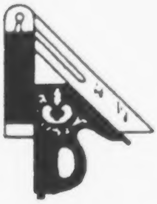
3. Adjust the blade on the bevel square so that it is at a graduation on the tongue of the framing square equal to the graduation scale at the handle of the bevel square. — — — —



4. Hold the bevel square with one hand and tighten the locking screw with the other hand. Ask instructor to check for an exact 45-degree angle on your bevel square. — — — —

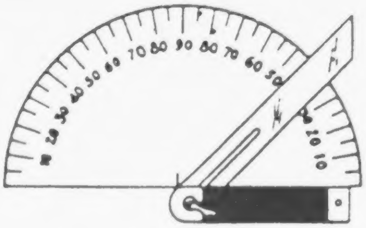
5. Loosen the thumb screw on a combination square and slide the handle off the scale. Loosen the locking screw on the bevel square so that the blade moves with a slight friction. — — — —

6. Place the handle of the combination square on a clean work area. Hold it in place with one hand. Adjust the blade on the bevel square so that it fits firmly over the 45-degree angle on the combination square. Tighten the bevel square locking screw. Ask instructor to check for an exact 45-degree angle on your bevel square. — — — —



7. Place a protractor on a clean work area. Loosen the locking screw on the bevel square so that the blade moves with a slight friction. — — — —

8. Place the handle of the bevel square at the bottom edge of the protractor. Hold it with one hand so that it is straight, exactly over the 45-degree angle on the protractor. Tighten the locking screw. Ask instructor to check for an exact 45-degree angle on your bevel square. — — — —



9. Return tools to proper storage area or prepare for next job sheet. — — — —

Average of above evaluation* — — — —

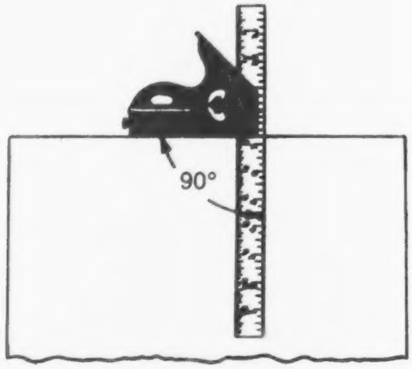
JS 1.2

USE COMBINATION SQUARE TO FORM 90- AND 45-DEGREE ANGLES

Equipment:

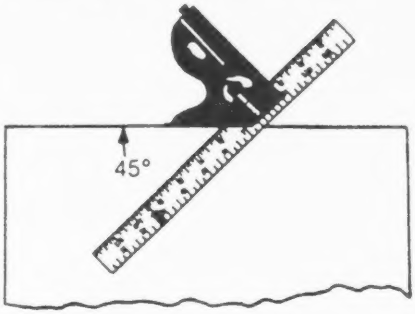
Combination square
Soapstone (sharpened)
Flat metal stock as selected by instructor
Framing square

Procedure:	Evaluation 3	 2	 1	 N
1. Place flat metal stock on a clean working area. Butt the flat part of the handle along the upper edge of the metal stock so the scale forms a 90-degree angle down the surface of the metal.	—	—	—	—
2. Loosen the thumb screw on the bevel and move the scale down the metal to a point where it indicates exactly 6". Tighten the thumb screw.	—	—	—	—
3. Mark the 6", 90-degree angle with soapstone. Ask instructor to check for an exact 90-degree angle and a distance of exactly 6".	—	—	—	—



4. Butt the flat part of the handle along the upper edge of the metal stock so the scale forms a 45-degree angle down and across the surface of the metal. Loosen the thumb screw on the bevel and move the scale down the metal to a point where it indicates exactly 6". Tighten the thumb screw.	—	—	—	—

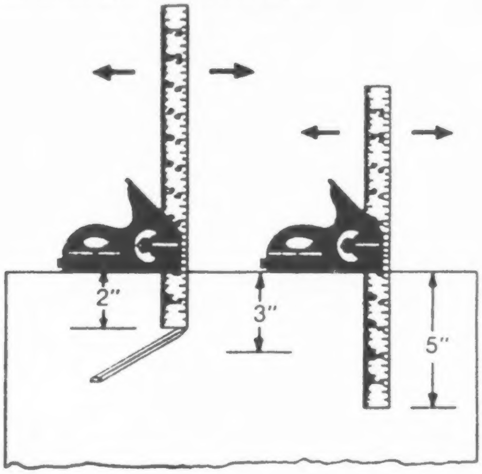
5. Mark the 6", 45-degree angle with soapstone. Ask instructor to check for an exact 45-degree angle and a distance of exactly 6". — — — —



6. Loosen the thumb screw and slide the scale out the 90-degree side of the handle to prepare for marking parallel lines on the metal. — — — —

7. Mark the 2" distance in two places along the left and right side of the metal. Reset the scale at the 3" mark and mark the 3" distance at two places along the left and right side of the metal. — — — —

8. Reset the scale at the 5" mark and mark the 5" distance at two places along the left and right side of the metal. — — — —



9. Remove the combination square. Line up the framing square along both 2" marks and draw a straight line across the metal with soapstone. — — — —

10. Line up the framing square along both 3" marks and draw a straight line across the metal with soapstone. — — — —

11. Line up the framing square along both 5" marks and draw a straight line across the metal with soapstone. — — — —

12. Ask instructor to check your work for parallel lines across the metal at points exactly 2", 3" and 5" from the top. — — — —

13. Clean up the area and return tools and materials to proper storage areas. _ _ _ _

Average of above evaluation* _ _ _ _

*With JS 1.1, this average is the student's partial evaluation for competency A6: Maintain, use and safely work with machines, tools and equipment, and partial evaluation for competency A10: Select, use and care for hand tools.

MODULE: BASIC WELDING SKILLS

UNIT VI: MATH AND MEASURING

LESSON 2: MIDPOINT AND PERIMETERS

I. Formulas for perimeters

   A. Rectangle: $P = 2L + 2W$

   B. Square: $P = 4s$

   C. Triangle: $P = s_1 + s_2 + s_3$

   D. Calculating perimeters for rectangles, squares and triangles

      1. Rectangle: length = 4', width = 3'

         $P = 2L + 2W$

         $P = (2 \times 4) + (2 \times 3)$

         $P = 8 + 6$

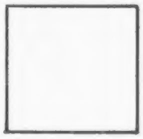
         $P = 14'$

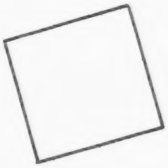
      2. Square: length of a side = 6"

         $P = 4s$

         $P = 4 \times 6$

         $P = 24"$



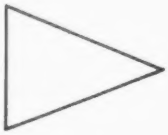


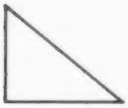
      3. Triangle: length of one side = 2', length of another side = 3', length of the third side = 4'.

         $P = s_1 + s_2 + s_3$

         $P = 2 + 3 + 4$

         $P = 9'$



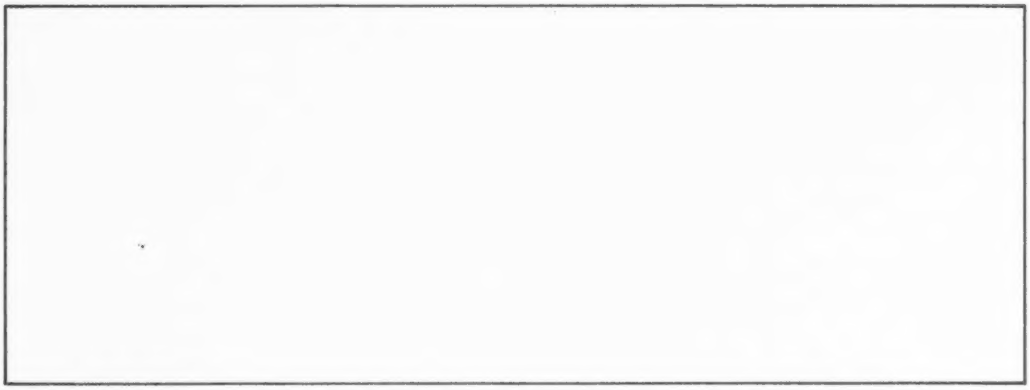


AS 2.1

FIND THE MIDPOINT OF GIVEN LINES AND FIGURES

1. How long is the line above?_______
2. 4 5/8 x 1/2 = 37/8 x 1/2 = 37/16 =_______
3. What is the length of half of the line above?______
4. Mark the midpoint of the line. Measure to be sure both parts are the same length.

5. What is the length of the bar above?_______
6. What is one-half the length of the bar?_____
7. Draw a line showing where the cut would be made to get two pieces each half as long as the original piece.



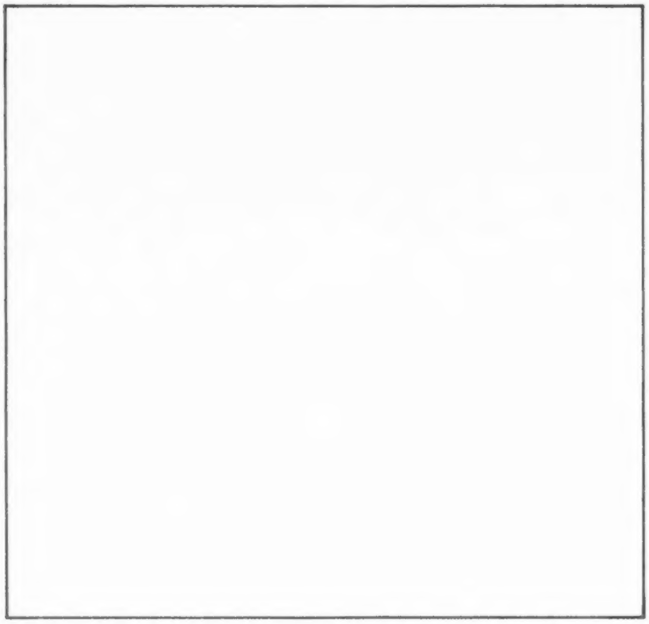
8. How long is the piece of aluminum above?_____
9. What is half its length?_______
10. Draw the cutting line on the figure. (You will need to mark the midpoint on each of the long sides and draw the line connecting these two points.)

11. How wide is the piece of aluminum?_______

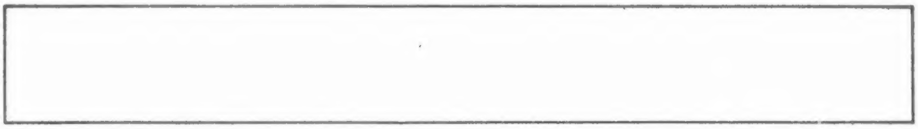
12. What is half its width?_________

13. Draw the cutting line that would divide the width in half. (Remember to mark the midpoints of both widths and to connect these two points.)

14. The point where the two lines cross is the center of the aluminum. If you were supposed to drill a hole in the center of the piece below, where would you place the hole? Circle the point on the drawing.



15. Perform the steps to locate and mark the point where you would drill a hole in the center of this figure.



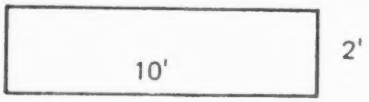
16. Mark the cutting line for cutting the length of the bar in half.

AS 2.2

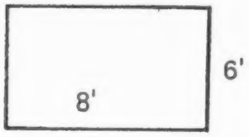
CALCULATE PERIMETERS OF RECTANGLES AND SQUARES

Calculate the perimeters for the following rectangles. Write the formula on each problem.

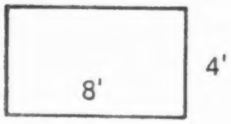
1.



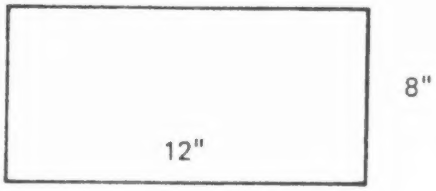
2.



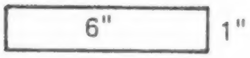
3.



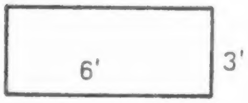
4.



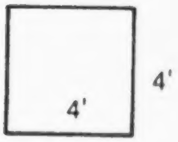
5.



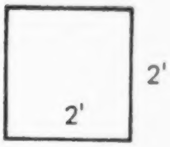
6.



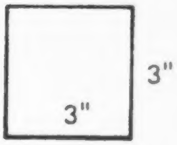
7.



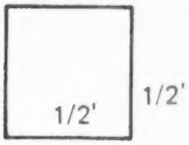
8.



9.



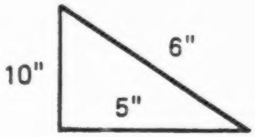
10.



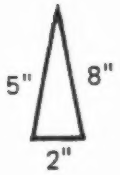
CALCULATE PERIMETERS OF TRIANGLES

Calculate the perimeters for each of the following triangles. Write the formula for each problem.

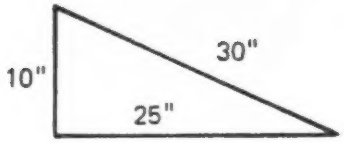
1.



2.



3.



4. $s_1 = 3/4'$, $s_2 = 5'$, $s_3 = 5'$

5. $s_1 = 2\ 1/8'$, $s_2 = 5\ 1/8'$, $s_3 = 9'$

6. $s_1 = 8\ 1/2'$, $s_2 = 2\ 1/4'$, $s_3 = 23\ 1/4'$

ANSWERS TO ASSIGNMENT SHEET 2.1

1. 4 5/8 inches
2. 2 5/16 inches
3. 2 5/16 inches
4. Teacher evaluation
5. 4 3/4 inches
6. 2 3/8 inches
7. Teacher evaluation
8. 5 7/8 inches
9. 2 15/16 inches
10. Teacher evaluation
11. 2 1/8 inches
12. 1 1/6 inches
13. Teacher evaluation
14. Teacher evaluation
15. Evaluated to the satisfaction of teacher
16. Evaluated to the satisfaction of teacher

ANSWERS TO ASSIGNMENT SHEET 2.2

1. 24'
2. 28'
3. 24'
4. 40"
5. 14"
6. 18'
7. 16'
8. 8'
9. 12"
10. 2'

ANSWERS TO ASSIGNMENT SHEET 2.3

1. 21"
2. 15"
3. 65"
4. 13 3/4'
5. 16 1/4'
6. 34'

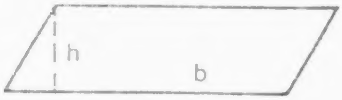
MODULE: BASIC WELDING SKILLS

UNIT VI: MATH AND MEASURING

LESSON 3: GEOMETRIC FIGURES

I. Formulas for calculating areas of basic geometric figures

A. Parallelogram: A = bh



Example: Parallelogram: b = 12", h = 7"

A = bh

A = 12 x 7

A = 84 square inches

B. Rectangle: A = lw

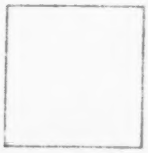
Example: Rectangle: l = 9 yards, w = 2 yards

A = l x w

A = 9 x 2

A = 18 square yards

C. Square: $A = s^2$



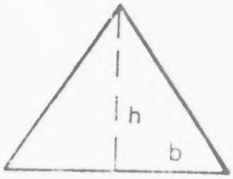
Example: Square: s = 10'

$A = s^2$

A = 10 x 10

A = 100 square feet

D. Triangle: A = 1/2 bh



Example: Triangle: b = 12", h = 7"

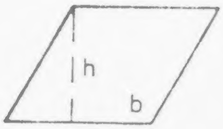
A = 1/2 bh

A = 1/2 x 12 x 7

A = 6 x 7

A = 42 square inches

E. Rhombus: A = bh



Example: Rhombus: b = 9 miles, h = 2 1/3 miles

A = bh

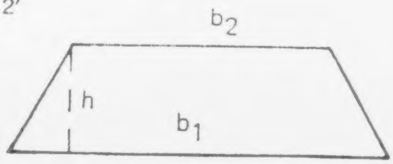
A = 9 x 2 1/3

A = 9/1 x 7/3

A = 63/3

A = 21 square miles

F. Trapezoid: A = 1/2 h (b_1 + b_2)



Example: Trapezoid: h = 7", b_1 = 8", b_2 = 5"

A = 1/2h (b_1 + b_2)

A = (1/2 x 7) (8 + 5)

A = (7/2)(13)

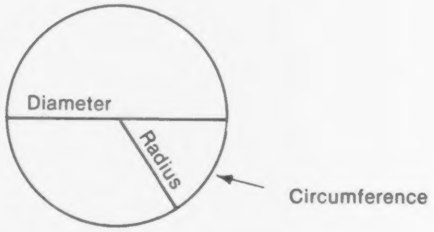
A = 7/2 x 13/1

A = 91/2

A = 45 1/2 square inches

G. Calculating circle measurement

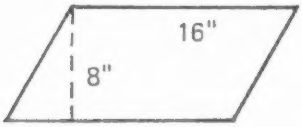
1. The diameter of a circle is equal to two times the radius, expressed as $D = 2R$.
2. The radius of a circle is equal to half the diameter, expressed as $R = D/2$.
3. The circumference of a circle is approximately equal to the diameter times 3.14, expressed as $C = 3.14D$ or $C = \pi D$.
4. The area of a circle is equal to the square of the radius times 3.14, expressed as $A = \pi R^2$.



AS 3.1

CALCULATE THE AREAS OF PARALLELOGRAMS, RECTANGLES AND SQUARES

1.



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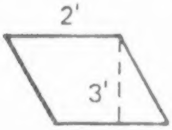

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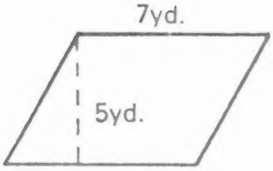
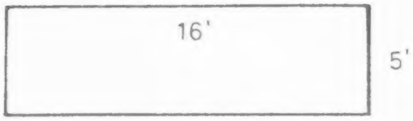


4. b = 4 1/2 miles, h = 5 1/3 miles

5.



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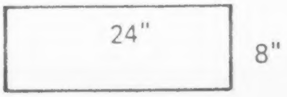

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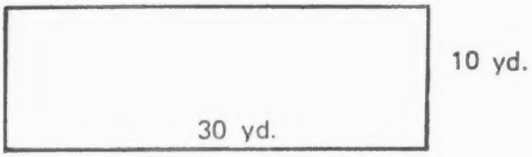
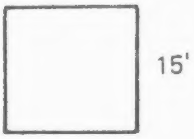


8. 1 = 4.6 yards, w = 8.4 yards

9.



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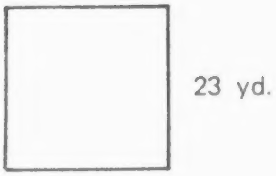


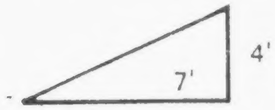
11. s = 10 1/2 miles

12. s = 14.8'

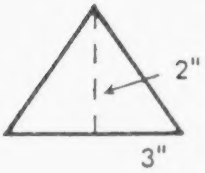
AS 3.2

CALCULATE THE AREAS OF TRIANGLES, RHOMBUSES AND TRAPEZOIDS

1.



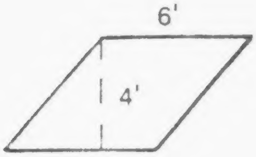
2.



3. b = 12", h = 8 1/2"

4. b = 3.2', h = 5.8'

5.



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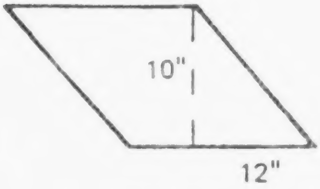

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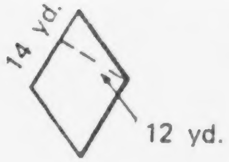
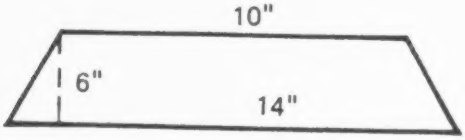


8. b = 30 1/4 miles, h = 8 1/2 miles

9.



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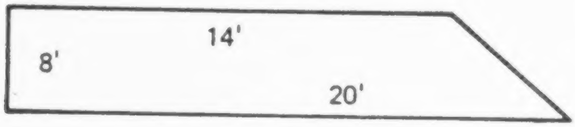
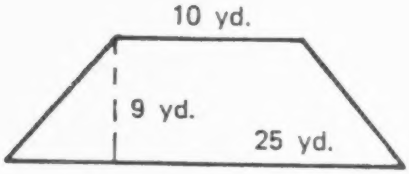


11.


10 yd.
9 yd.
25 yd.

12. h = 12 miles, b_1 = 5 1/2 miles, b_2 = 7 1/2 miles

CALCULATE THE CIRCUMFERENCES AND AREAS OF CIRCLES

Solve for the circumferences of the following circles (use pi = 3.14).

1. Diameter = 4 feet
2. Diameter = 6 inches
3. Radius = 1.5 inches
4. Diameter = 8 yards
5. Radius = 8 yards

Solve for the areas of these circles.

6. Radius = 6 inches
7. Diameter = 10 feet
8. Diameter = 14 feet
9. Radius = 2.5 inches
10. Radius = 8 feet

ANSWERS TO ASSIGNMENT SHEET 3.1

1. 128 square inches
2. 6 square feet
3. 35 square yards
4. 24 square miles
5. 80 square feet
6. 192 square inches
7. 300 square yards
8. 38.64 square yards
9. 225 square feet
10. 529 square yards
11. 110 1/4 square miles
12. 219.04 square feet

ANSWERS TO ASSIGNMENT SHEET 3.2

1. 14 square feet
2. 3 square inches
3. 51 square inches
4. 9.28 square feet
5. 24 square feet
6. 120 square inches
7. 168 square yards
8. 257 1/8 square miles
9. 72 square inches
10. 136 square feet
11. 157 1/2 square yards
12. 78 square miles

ANSWERS TO ASSIGNMENT SHEET 3.3

1. 12.56 feet
2. 18.84 feet
3. 15.70 inches
4. 25.12 yards
5. 50.24 yards
6. 113.04 square inches
7. 78.50 square feet
8. 153.86 square feet
9. 19.625 square inches
10. 200.96 square feet

MODULE: BASIC WELDING SKILLS

UNIT VI: MATH AND MEASUREMENT

LESSON 4: SIZING STEEL

I. Methods of sizing commonly used steel stock

A. Square bars are sized according to thickness and width and come in various lengths.

W = Width

T = Thickness
1/4" to 2 3/4", in graduations of 1/16" and 1/8"

L = Length - 16', 20', 36'

B. Hot and cold-rolled flat bars are sized according to thickness and width and come in various lengths.

T = Thickness
1/4" to 1/2" in graduations of 1/16"; 1/2" to 1 1/4" in graduations of 1/8"
1 1/4" to 2' in graduations of 1/4"
(3/16" and lighter, see strips)

W = Width - 3/8" to 6" in graduations of 1/8"

L = Length - 16', 36'

C. Structural H beams are sized according to height and width of beam.

NOTE: Structural H beams are also called WF beams to indicate that they are wide-flange beams. The inside angle of the flange is parallel or almost parallel with the top and bottom surface of the flange.

S = Size - 3", 4", 6" and larger

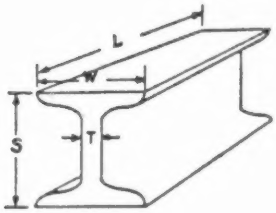
W = Width of flange

T = Thickness of web

L = Length - 5' to 60'

D. Structural I beams are sized according to height and width of beam and come in various lengths.

NOTE: Structural I beams are also called standard beams or S beams and are relatively easy to distinguish from H or wide beams because the inside angle always has a definite slope.



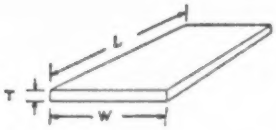
S = Size
4 x 4
5 x 5
6 x 6

W = Width of flange (same as S)

T = Thickness of web

L = 5' to 60'

E. Hot-rolled strips 3/16" or less in thickness are sized according to thickness and width and come in various lengths.



T = Thickness
(thickness measurement expressed in fractions of an inch and gauge number)

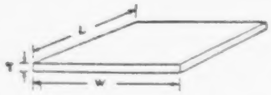
# 10 (.134); 1/8" (.125")
# 12 (.109")
# 14 (.083")
# 16 (.065")
# 18 (.049")
# 20 (.035")
# 22 (.028")

W = Width
3/8" to 2" in graduations of 1/8"
2" to 3 1/2" in graduations of 1/4"
3 1/2" to 6" in graduations of 1/2"
6" to 12" in graduations of 1"

L = Length - 14' to 16'

F. Hot and cold-rolled sheets are sized according to thickness and width and listed by gauge number.

NOTE: Rolled steel 3/16" or less is classified as sheet, and over 3/16" is classified as plate.

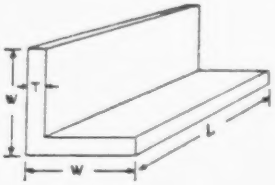


T = Thickness - 3/16" and less expressed according to gauge number
3/16"
8 (.1644")
10 (.1345")
11 (.1196")
12 (.1046")
14 (.0747")
# 16 (.0598")
18 (.0478")
# 20 (.0359")
22 (.0299")
# 24 (.0239")
# 26 (.0179")
# 28 (.0149")

W = Width - measurements given in inches -
30", 36", 42", 54", 60", 72", 84"

L = Length - measurements given in inches -
96", 120", 144", 156", 240"

G. Bar and structural angles are sized according to width times thickness and come in various lengths.



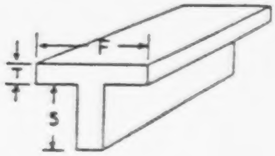
W = Width
1/2" to 1 1/2" in graduations of 1/8" flange
1 1/2" to 1 1/2" in graduations of 1/4"
3" and over structural steel

T = Thickness of flange 1/8" to 1/2" in graduations of 1/16"

Angle stock is manufactured in unequal width of flanges, example: 1 1/2" x 1 1/2"

L = Length - 16', 18', 20'

H. Bar and structural Ts are sized according to flange width times stem times thickness and come in various lengths.

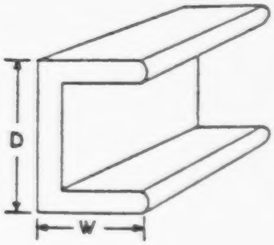


F = Flange width
3/4" to 1 1/2" in graduations of 1/4"

S = Stem width
3/4" to 2 1/2" in graduations of 1/4"

T = Thickness
1/8" to 3/8" in graduations of 1/16"

I. Bar size channels are sized according to depth times width of flange times thickness of web and come in various lengths.



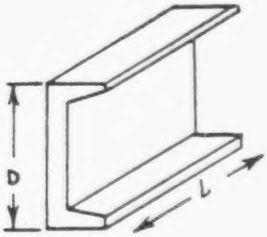
D = Depth
1/2" to 3/4" in graduations of 1/16"
3/8" to 1 1/4" in graduations of 1/8"
1 1/4" to 2" in graduations of 1/4"

W =Width (of flange) 164, 5/16, 3/8, 6

W = Width (of flange)
1/4", 5/16" 3/8", 7/16", 1/2", 9/16", 3/4", 1"

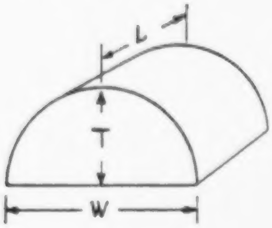
T = Thickness of web
1/8", 3/16", 1/4"

J. Structural channels are sized according to depth of channel.



Common sizes are 3", 4", 5", 6", 7", and 8".

K. Hot-rolled half ovals are sized according to thickness and width and come in 16' lengths.

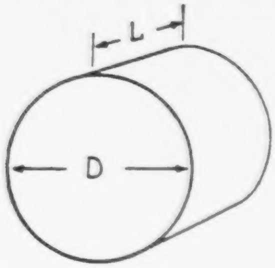


T = Thickness
3/8" to 1/2" in graduations of 1/16"

W =Width
1/8" to 1 1/4" in graduations of 1/8"
1 1/4" to 2" in graduations of 1/4"
2" to 3" in graduations of 1/2"

L = Length - 16'

L. Hot and cold-rolled rounds are sized according to length and diameter.



D = Diameter 3/8" to 2" or larger in graduation increases of 1/16" and 1/8"

L = Length - 16', 18' and 20'

MODULE: BASIC WELDING SKILLS

UNIT VI: MATH AND MEASUREMENT

UNIT TEST

- Decimal Equivalent Chart -

1/64	.015625	33/64	.515625
1/32	.03125	17/32	.53125
3/64	.046875	35/64	.546875
1/16	.0625	9/16	.5625
5/64	.078125	37/64	.578125
3/32	.09375	19/32	.59375
7/64	.109375	39/64	.609375
1/8	.125	5/8	.625
9/64	.140625	41/64	.640625
5/32	.15625	21/32	.65625
11/64	.171875	43/64	.671875
3/16	.1875	11/16	.6875
13/64	.203125	45/64	.703125
7/32	.21875	23/32	.71875
15/64	.234375	47/64	.734375
1/4	.25	3/4	.75
17/64	.265625	49/64	.765625
9/32	.28125	25/32	.78125
19/64	.296875	51/64	.796875
5/16	.3125	13/16	.8125
21/64	.328125	53/64	.828125
11/32	.34375	27/32	.84375
23/64	.359375	55/64	.859375
3/8	.375	7/8	.875
25/64	.390625	57/64	.890625
13/32	.40625	29/32	.90625
27/64	.421875	59/64	.921875
7/16	.4375	15/16	.9375
29/64	.453125	61/64	.953125
15/32	.46875	31/32	.96875
31/64	.484375	63/64	.984375
1/2	.5	1	1.

- Inches to Decimal Conversion Chart -

Fractions of inches	
1/16"	.0052
3/32"	.0078
1/8"	.0104
5/32"	.0130
3/16"	.0156
7/32"	.0182
1/4"	.0208
9/32"	.0234
5/16"	.0260
3/8"	.0313
7/16"	.0364
1/2"	.0417
9/16"	.0468
5/8"	.0521
11/16"	.0572
3/4"	.0625
13/16"	.0677
7/8"	.0729
15/16"	.0781

Inches	
1"	.0833
2"	.1667
3"	.2500
4"	.3333
5"	.4167
6"	.5000
7"	.5833
8"	.6667
9"	.7500
10"	.8333
11"	.9167
12"	1.0000

Use the charts above to answer the next three questions.

____ 1. What is the decimal equivalent for a 1/16" thick piece of steel tubing?

a. .046875 c. .078125
b. .0625 d. .125

____ 2. A piece of steel round bar is 8" long. In decimals, what portion of a foot is 8"?

a. .0104 c. .5833
b. .4167 d. .6667

____ 3. If steel segments 3/8" and 3/4" in length were welded together end to end, what would be their total length (in decimals)?

a. 1.025" c. 1.120"
b. 1.10" d. 1.125"

	When You Know	You Can Convert To	When You Multiply By
LENGTH	Inches	Millimeters (mm)	25.4
	Millimeters	Inches	0.04
	Inches	Centimeters (cm)	2.54
	Centimeters	Inches	0.4
	Inches	Meters (m)	0.0254
	Meters	Inches	39.37
	Feet	Centimeters	30.5
	Centimeters	Feet	4.8
	Feet	Meters	0.305
	Meters	Feet	3.28
	Miles	Kilometers (km)	1.61
	Kilometer	Miles	0.62
WEIGHT (MASS)	Ounces	Grams	28.4
	Grams	Ounces	0.035
	Pounds	Kilograms	0.45
	Kilograms	Pounds	2.2

Use the English-metric conversion chart to answer the next two questions.

____ 4. A bag of flux weighs 40 pounds. How many kilograms does the bag of flux weigh?

a. 18
b. 20.5
c. 22.7
d. 25

____ 5. A part that is 5 meters in length is _____ feet long.

a. 10
b. 12.5
c. 15
d. 16.4

____ 6. The perimeter for a rectangle 4' in length and 3' in width is ___.

a. 7'
b. 12'
c. 14'
d. 24'

____ 7. The perimeter for a square with 7" sides is _____ .

a. 28"
b. 30"
c. 42"
d. 49"

____ 8. A triangle with sides of 3", 5" and 7" has a perimeter of ____ .

a. 10"
b. 15"
c. 17"
d. 23"

____ 9. A parallelogram with a base of 10" and a height of 4" has an area of _____ .

- a. 50 sq. in.
- b. 40 sq. in.
- c. 20 sq. in.
- d. 14 sq. in.

____ 10. A rectangle with a length of 6 yards and a width of 3 yards has an area of ____ .

- a. 19 yds.
- b. 18 sq. yds.
- c. 9 sq. yds.
- d. 9 sq. ft.

____ 11. A 5' sided square has an area of _____ .

- a. 25 sq. in.
- b. 20 sq. ft.
- c. 25 sq. ft.
- d. 25 sq. yds.

____ 12. A triangle with a base of 4' and a height of 3' has an area of __.

- a. 6 sq. ft.
- b. 7 sq. ft.
- c. 7 sq. yds.
- d. 12 sq. ft.

____ 13. What is the area of a rhombus with a base of 9' and a height of 6'?

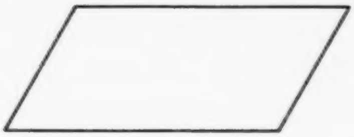
- a. 54 sq. in.
- b. 60 sq. in.
- c. 45 sq. ft.
- d. 54 sq. ft.

____ 14. A trapezoid with a height of 6", one base of 4" and another base of 3" has an area of ________ .

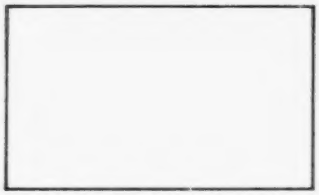
- a. 21 sq. in.
- b. 21"
- c. 23 sq. in.
- d. 27 sq. in.

Identify basic geometric figures by writing the letter of the correct name below each of the following illustrations.

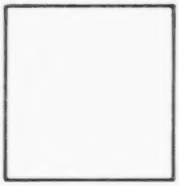
a. Triangle
b. Trapezoid
c. Square
d. Rhombus
e. Rectangle
ab. Parallelogram



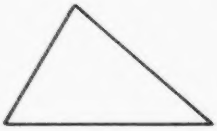
15. ________



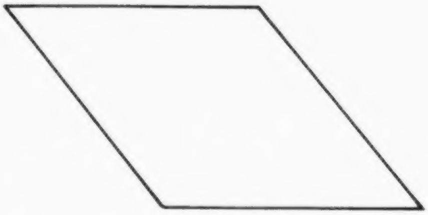
18. ________



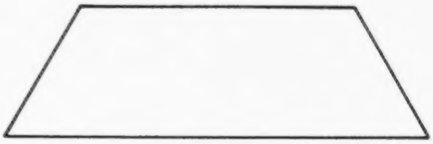
16. ________



19. ________



17. ________



20. ________

Choose the option which best answers the question or completes the statement.

____ 21. What is the diameter of a circle with a 3' radius?

a. 6'
b. 9'
c. 9.42'
d. 30'

____ 22. A circle with a 9' diameter has a radius of _____ .

a. 18'
b. 5'
c. 4 1/2'
d. 4'

____ 23. What is the circumference of a circle with a 6' diameter?

a. 28.84'
b. 19.94'
c. 18.84'
d. 17.84'

____ 24. A circle with a radius of 4" has an area of _____ .

a. 5.024"
b. 5.24"
c. 40.24"
d. 50.24"

____ 25. The midpoint of a workpiece 5 3/4" in length is _____ .

a. 2 7/8"
b. 2 5/8"
c. 2 19/32"
d. 2 7/16"

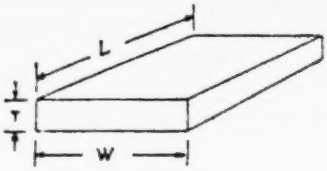
____ 26. A workpiece 3 2/3 yards in length has a midpoint of _____ .

a. 5 1/2 ft.
b. 1 4/6 yds.
c. 4 ft.
d. 1 1/3 yds.

For the last three questions of this test, use the scale of 1/8" = 1" to determine from drawings the actual size of the steel stock shown. Use a standard ruler marked in sixteenths of an inch.

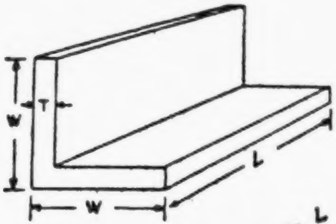
____ 27. What is the actual thickness of this piece?

a. 1 1/4"
b. 1 1/2"
c. 1 5/8"
d. 1 3/4"



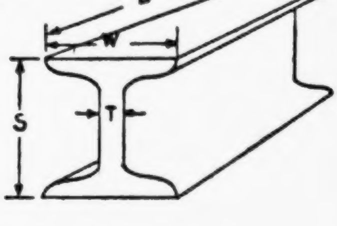
____ 28. What is the actual width of this piece?

a. 4 1/2"
b. 5"
c. 5 1/2"
d. 6"



____ 29. What is the actual length of this piece?

a. 8"
b. 9"
c. 10"
d. 11"



NOTE: Completion of the pre-test and this unit test to the specified score is the student's final evaluation for competencies A7 and A8.

ANSWERS TO UNIT TEST

1.	b	(A7)
2.	d	(A7)
3.	d	(A7)
4.	a	(A7)
5.	d	(A7)
6.	c	(A8)
7.	a	(A8)
8.	b	(A8)
9.	b	(A8)
10.	b	(A8)
11.	c	(A8)
12.	a	(A8)
13.	d	(A8)
14.	a	(A8)
15.	ab	(A8)
16.	c	(A8)
17.	d	(A8)
18.	e	(A8)
19.	a	(A8)
20.	b	(A8)
21.	a	(A8)
22.	c	(A8)
23.	c	(A8)
24.	d	(A8)
25.	a	(A8)
26.	a	(A8)
27.	b	(A8)
28.	d	(A8)
29.	c	(A8)